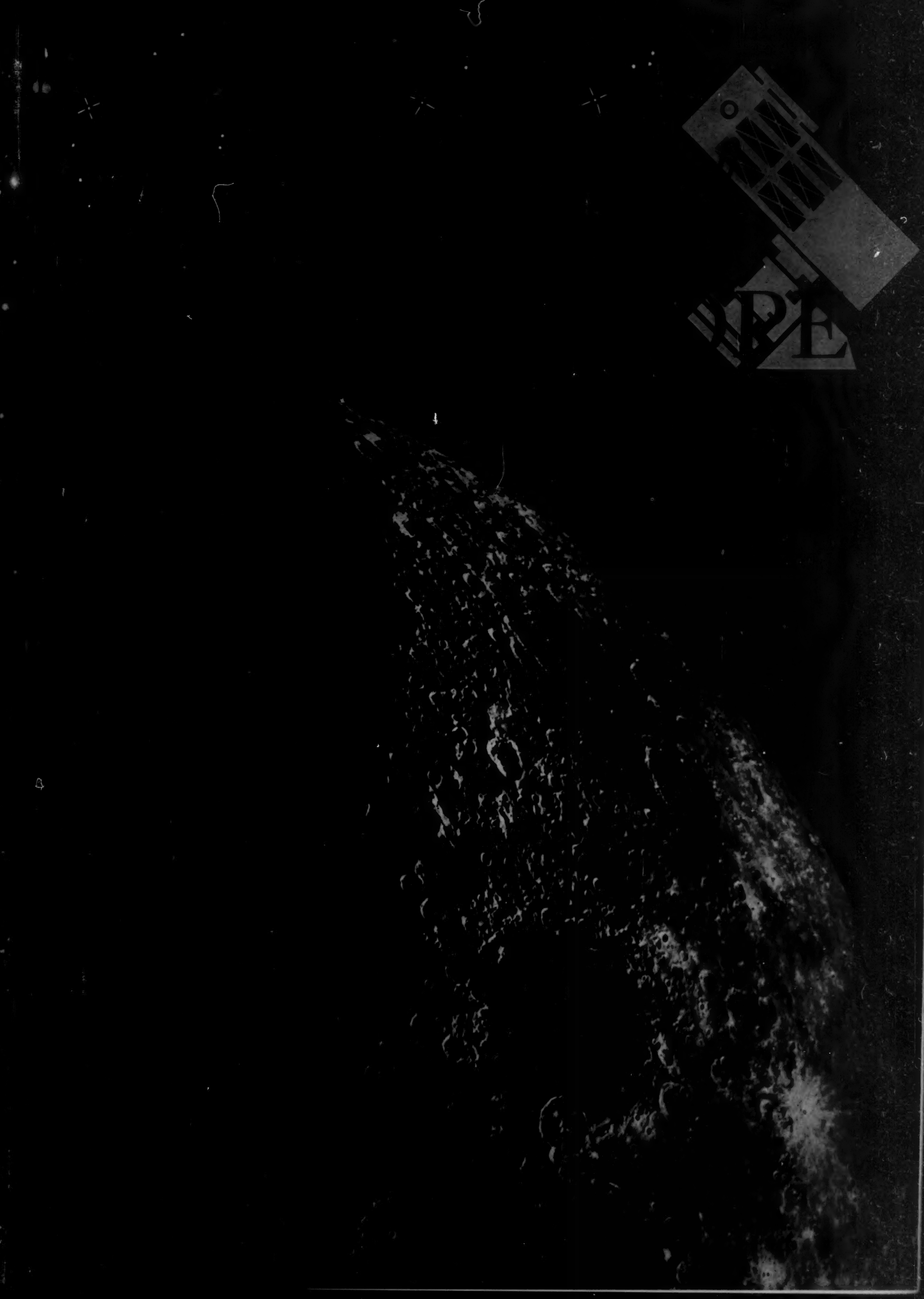


In Focus

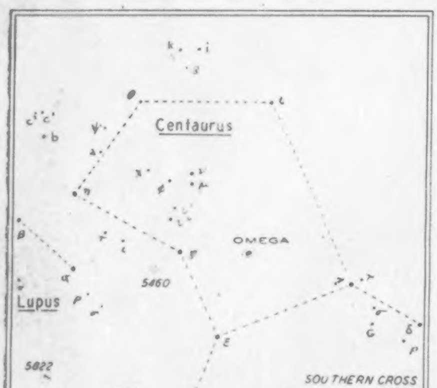
ON THE 13th of this month the moon will have about the same "age" as it does on the front cover of this issue. Because a telescope inverts the image, this is the southern portion of the visible crescent, and south is at the top of the picture. Schickard is the large walled plain 3½ inches from the top and left edge; just above it is Wargentin, the famous crater which has been filled almost to the level of its walls. Mare Humorum, about 250 miles in diameter, is just below the center of the picture, with the crater Gassendi at its northern edge.

The famous constellation of the Southern Cross, and part of Centaurus and the southern Milky Way appear on the back cover. The diagram below indicates positions of the brightest stars and clusters in the field. Particularly noticeable is the globular cluster, Omega Centauri, which presents a large image, at first inspection almost like that of a bright, blue star. It appears in the sky as a star of the 4th magnitude.

NGC 5822 is the most conspicuous open cluster in this field; it is made up of stars of 9th to 12th magnitude. Just south of it is NGC 5823, another large cluster, whose members are chiefly of magnitudes 13 and 14.

Three of the stars in Crux are blue, but Gamma, at the top of the cross, is of spectral type M, so on this blue-sensitive plate it is very inconspicuous, compared with its visual magnitude of 1.6. Another striking example of redness is Theta Centauri, visually of magnitude 2.3, but faint here because it is spectral type K0—an orange star.

Rich in stars both bright and faint, and in clusters and dark nebulosity such as the famous Coal Sack, this region of the sky presents an excellent example of galactic concentration. The field is centered about 13 degrees north of the galactic equator, at galactic longitude 280°, some 45° west of the center of the Milky Way.



Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor* HELEN S. FEDERER, *Managing Editor*

William Henry Barton, Jr.

WITH DEEP regret we learn of the untimely death on July 7, 1944, of William H. Barton, Jr., curator of the Hayden Planetarium in New York, on his 51st birthday.

Mr. Barton, who had been associated with New York's planetarium and the American Museum of Natural History since 1935, and before that had been a lecturer at the Fels Planetarium in Philadelphia, is well known, by name at least, to thousands of readers of The SKY and of **Sky and Telescope.** His interest in the magazine since its inception as the Hayden Planetarium **Monthly Bulletin**, and through its subsequent growth, was always strong and loyal.

Since The SKY's first appearance in November, 1936, until early this spring, when he was taken ill with heart trouble, Mr. Barton contributed 70 full-length articles based on the current demonstration in the planetarium. Each of these, at the same time, was a lively and informative account of some phase of popular astronomy. Other articles, book reviews, and short notes also appeared under his name.

Trained as an engineer, Mr. Barton early became interested in astronomy and in 1928 published his **Guide to the Constellations** in collaboration with Samuel G. Barton, of the University of Pennsylvania. The book is now in its third edition. More recently, with J. M. Joseph, Mr. Barton published **Starcraft,** primarily for junior astronomers. His latest efforts have been in the field of navigation, as a result of his intensive work in presenting navigation to the Navy and the public at the planetarium. **Stereopix,** three-dimensional celestial navigation, and **World Wide Planisphere,** reviewed in this issue, are among the most novel and unusual of his recent publications.

VOL. III, No. 10
Whole Number 34
AUGUST, 1944

CONTENTS

FRONT COVER: Southern portion of the moon, age 24 days, photographed with the 100-inch Mount Wilson reflector. Further facts concerning this picture are in the adjoining "In Focus" column. (See page 3.)

BACK COVER: The southern Milky Way in Centaurus and Crux, photographed at Harvard's Bloemfontein station with a Ross-Tessar 3-inch camera, exposure 3 hours, on July 10-11, 1934; scale is the same as on the back cover for July, 1944.

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A TRIP TO THE MOON

BY MARIAN LOCKWOOD

In the Hayden and Buhl Planetariums this month visitors will take a trip to the moon. Here are some facts about the moon, as we see it in the sky, and as we might observe it from its surface.

The lunar mountain Pico, as it might look to a visitor on the moon. From Nasmyth and Carpenter, "The Moon."

THE romance of exploration is not dead. True, there are few frontiers left unexplored upon the face of our planet, but down into the microscopic universe beyond the power of man's eye, and out into the vast cosmos of the galaxies, stretch new boundaries and new horizons. These are waiting for the courage and the intelligence of the exploring mind; for the great explorers of the future will be the men and women who probe the depths of space, and the depths of the infinitely small.

There are many experts who believe, too, that the day may not be far distant when we shall be exploring outer space in person — possibly 500 years from now, possibly in 1,000 years. Some think it may come even sooner than that, after the war perhaps, when men's minds will turn once more to the peacetime utility of rockets and rocket ships. Perhaps, they say, before some now alive have died, rocket-liner trips to the moon may be a common daily performance. This is wild supposition, not scientific statement. But there are those who believe it.

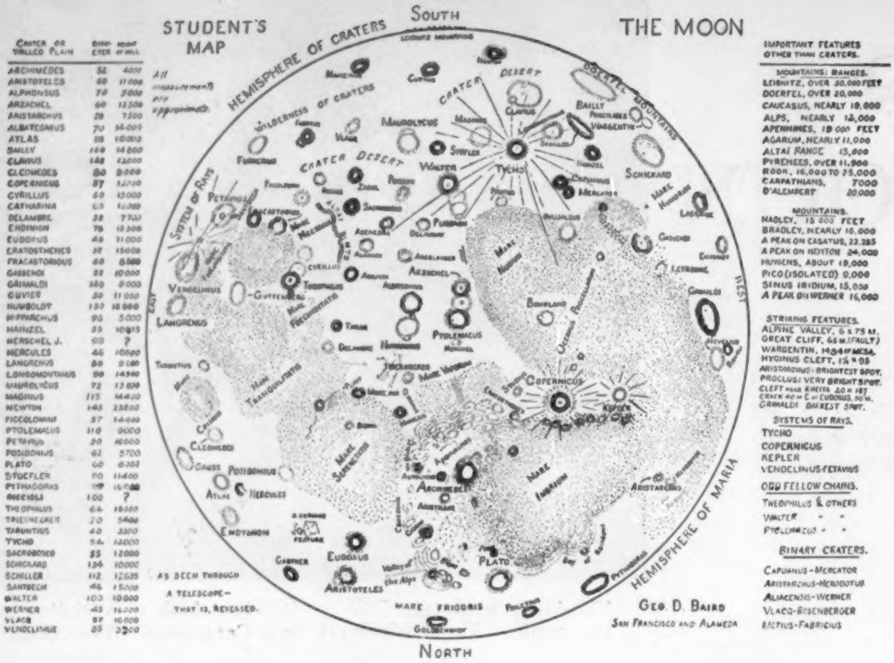
Mare Imbrium, bordered by the Apennines (upper left), and the Alps (lower left center) which are near the dark ring plain, Plato. Mount Wilson photo.

Let us imagine that we are about to journey to the moon, for that would be the easiest of the heavenly bodies to reach. We shall leave to later explorers the first breath-taking trip to Mars. We shall content ourselves with the moon, a mere hand's breadth away in space, at an average distance of about 239,000 miles from the earth. At the moon's closest approach, *perigee,* the distance may be as little as 222,000 miles and at *apogee,* when it is most distant, the moon may be some 253,000 miles away.

We shall find conditions on the moon very different from those on the earth, largely because there is no appreciable atmosphere surrounding our satellite. And right here you may ask the question, "How do we know, before taking this trip, that there is no air there?" There is one very simple way in which you can prove it for yourself, without any particular equipment other, perhaps, than a good pair of binoculars or opera glasses. Every now and then the moon, which is the nearest of all the heavenly bodies, comes between us and a star or a planet. This hiding of a celestial object by the moon is called an *occultation,* and when it occurs the body occulted can be seen to disappear instantaneously behind the edge or limb of the moon. If the moon had a perceptible atmosphere, this would not be true, but the occulted body would disappear gradually into the atmosphere before it was completely hidden by the solid body of the moon itself. Furthermore, there is no evidence of the displacement of the body which would be caused by refraction if an atmosphere were present on the moon.

So perhaps the most important thing we know about the moon before we start is that we must be prepared for a lack of air. This means that we shall have to carry with us our own supply of oxygen to breathe while we are there.

And when we have arrived, let us say, set down in our marvelous rocket ship in the center of a crater on the moon, we shall shortly become aware of other odd features about our new environment. One of the things we notice first is the absence of "weather" in the ordinary sense of the word. There would be no need on the moon for a weatherman; it is possible to foretell the weather there at any time in the future with almost absolute exactness. Weather as we know it occurs only in the atmosphere, and where there is no atmosphere there can be no weather, except as the temperature changes from hot to cold and cold to hot. At noon we shall find ourselves uncomfortable, to say the least, with the temperature up to 214° F. At midnight we shall be quite as uncomfortable in the other direction, as the temperature then drops to —243° F., a range of over 450° in one period of day and night. It must be remembered, of course, that day and night together on the moon occupy a time about equal to our month. For the moon's rotation is accomplished in exactly the same period as its revolution around the earth and in the same direction. Consequently, daylight at any one place on the moon lasts about two weeks, and night the same length of time.



The names of many of the lunar features are shown on this map of the moon, drawn by George D. Baird.

But weather, in any other sense than that of change of temperature, does not exist on the moon. There are never clouds in the sky, it never rains, hails, or snows. There are as a consequence no bodies of water such as oceans, lakes, or rivers. The wind never blows on the moon, not even a gentle evening breeze as the sunset light fades from the top of some lofty lunar mountain. Stillness—forever stillness.

This stillness is more than a matter of moving air, however, for where there is no air there can be no sound. Neither would it be possible to smell anything on the moon, for without air the act of smelling would be an impossibility.

We say commonly that we can see only one side of the moon, since that body rotates on its axis once in the length of time it takes to revolve around the earth. But we are able, actually, to see at one time or another about 59 per cent of the moon's surface, the remaining 41 per cent being hidden from us always. We see the extra nine per cent of the moon because of what are known as *librations,* of which there are three principal kinds.

The libration in latitude is caused by the 6½-degree inclination of the moon's equator to the plane of its orbit around the earth, just as the earth's equator is inclined to the plane of the ecliptic. This inclination makes it possible for us first to peek a little over one pole of the moon and two weeks later over the other.

The libration in longitude is caused by the fact that although there is no variation in the rate of the moon's rotation, there is a decided variation in its rate of revolution around the earth because of its varying distance from us. This enables us to see at times a little bit more than usual of the western side, and at other times a little bit more of the eastern side of the moon.

The third libration is known as diurnal libration, and is caused by the observer's change of viewpoint as the earth rotates. In other words, because he is 4,000 miles from the center of the earth, the observer sees a slightly different hemisphere of the moon when it is rising than when it is near the western horizon.

The moon is considerably smaller than the earth, its diameter being 2,160 miles, or about one quarter the earth's diameter. Its mass is 1/81.5 that of the earth, a fact which makes it immediately evident that when you visit the moon you will find you do not weigh as much as you did on the earth. You will weigh, actually, just about one sixth of what you did at home. This brings up interesting effects, for you can jump several times as high, and throw a ball six times as far, and also you will have less difficulty in climbing mountains than on the earth. If, on the other hand, the moon were more massive than the earth, as is Jupiter, you would then find your extra weight a great handicap and even the slightest motion would be fraught with difficulty. On the moon, though, you are certainly light-footed.

The moon's mountains are surprisingly high in relation to its size. The highest rises to some 25,000 feet above the mean level of the surface. This, it is true, is less than the height of Mt. Everest above sea level, but it is a truly great height when one bears in mind how much smaller the moon is than the earth. There are ranges of mountains on the moon, also, and they have names that sound familiar to our earthly ears — the Apennines, the Alps, and the Caucasus. The Apennines form a truly imposing and magnificent range rising some 18,000 stately feet above the plains.

The entire surface of the moon is rough and rugged in the extreme, and exploring here would be difficult indeed. Galileo, gazing rapt and silent at the moon through his inadequate little telescope, saw with interest and curiosity the dark areas of our satellite which form part of the familiar physiognomy of the "man in the moon." To him these dark regions looked like great seas of water, and they have been called ever since by the generic name he gave them, *maria* from the Latin for *seas.* It has not mattered that the absence of water on the moon was soon discovered and that the maria were great, flat plains devoid of water.

The larger and more conspicuous of the lunar maria are called Mare Tranquilitatis, Mare Serenitatis, and Mare Imbrium—the Sea of Tranquility, the Sea of Serenity, and the Sea of Shadows. Here too are to be found the Sea of Showers and the Sea of Honey.

Upon closer examination, it is easily seen that these plains are not entirely flat and unmarred. Here and there upon their surfaces are roughnesses of one kind or another, small craters, rills, crevices, hills, and various other kinds of irregular markings.

Outstanding on the moon are more than 30,000 craters that pockmark its surface. These craters are of various types and of all sizes. The average, typical lunar crater is surrounded by a raised rim. The crater floor may lie above or below the average level of the moon's surface. Some of the larger craters contain mountain peaks in their centers. The largest craters on the moon are about 150 miles in diameter, while many of them are so small that even in very large telescopes they appear simply as tiny dark dots.

One of the most famous of all astronomical controversies is that concerning the probable origin of the lunar craters. Many astronomers believe that the craters are the result of

NEWS NOTES

By Dorrit Hoffleit

LEGION OF MERIT TO AN ASTRONOMER

Among numerous honors conferred by the War Department, as of May 16, 1944, we note that Lt. Martin Schwarzschild, astronomer on leave from Columbia University, has been awarded the Legion of Merit. Of the 17 officers who were accorded this distinction at the same time, none of the others held a rank lower than that of major, whereas Lt. Schwarzschild (2nd Lt.) received it in recognition of work done while he was a private. The citation reads:

"For exceptionally meritorious conduct in the performance of outstanding services from 4 March to 4 July 1942. As Instructor in the Meteorological Section, Master Gunners School, Antiaircraft Training Center, Camp Stewart, Georgia, Private Schwarzschild devised and perfected an improved and faster method of securing ballistic data for use of antiaircraft artillery which after thorough test was adopted as the standard Army system. The relative simplicity, ingenuity, and accuracy of the *Schwarzschild* system marks a distinct advance in the methods of preparing meteorological messages and results in an important saving of time, equipment, and personnel required for the determination of these essential data."

We understand that Lt. Schwarzschild is now on overseas duty.

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volcanic action on the moon in times past. Close observation shows that many of these lunar craters do seem to resemble terrestrial volcanoes. Some of the proponents of this theory say that the craters on the moon are explosive craters. Occasionally, the observer will notice cones within cones, which may point to volcanic origin, as may also the fact that the surface of the moon almost appears to be covered with considerable dust.

Many astronomers, on the other hand, believe that the craters on the moon originated as the result of the fall of meteors. When the moon was young, large meteorites falling into its surface might very well have caused the craters as we know them at the present time.

There are many arguments which can be marshaled against both of these theories, but for the present, until we can observe them more closely, and have collected more data, the cause of the lunar craters must remain undetermined.

In the meantime, night after night, the moon rides serenely across our skies. The lunar orb changes from crescent to full, and full circle to crescent again, ever presenting a face of incredible beauty.

SCOTTISH ASTRONOMY

On the 20th of April, the Scottish Branch of the British Astronomical Association celebrated its jubilee at Glasgow. Sir Harold Spencer Jones spoke on "Life on Other Worlds." The occasion offers opportunity to review briefly the success of astronomy in Scotland. At Glasgow, the chair of practical astronomy at the University was founded in 1760; but for two centuries previously astronomy had been taught as a branch of physics or mathematics. Much important research, including work in celestial mechanics and the compilation of large star catalogues, has been and is being done by Glasgow astronomers.

Citizens of the city have intermittently shown much interest in the subject. In 1808, The Glasgow Society for Promoting Astronomical Observations was formed. It subscribed £5,000 toward the purchase of a site for an observatory. Enthusiasm waned, however, to become revived about 1837 by the brilliant popular lectures of the university astronomer, J. P. Nichol.

The West of Scotland branch of the B.A.A. was formed in Glasgow in 1894. The sphere of its activity grew, and in 1937 the name was changed to Scottish Branch.

From the leaflet announcing the jubilee, which was kindly sent by Charles T. Melvin, convener of the jubilee committee, we quote a characteristic thought: "Glasgow citizens know how to follow trade and commerce to the ends of the earth; they also know how to follow the light of pure knowledge that would reveal some of the mystery of the Universe."

MICHIGAN OBSERVATORIES

Few universities can boast the operation of three major observatories. The University of Michigan has the observatory of the university at Ann Arbor, the Lamont-Hussey Observatory at Bloemfontein, South Africa, and the McMath-Hulbert Observatory at Lake Angelus, Mich.

A group of reprints (from the *University of Michigan—An Encyclopedic Survey, Part III*) giving the history of Michigan's department of astronomy and the evolution of its observatories has recently been received. The history, showing large fluctuations in hopes *vs.* accomplishments of its successive administrators, in which achievements finally predominate, makes good reading.

Beginning with the appointment of the Prussian astronomer, Brünnow, as the first director of the first observatory at Ann Arbor in 1854, Michigan has maintained one of the leading roles in advanced instruction in astronomy. At Ann Arbor now education and research are of comparable importance. The Annual Report for 1942-43 notes that 670 students in the university were taking courses in astronomy. Research projects include spectrographic work with the 37½-inch reflector.

Double stars, their discovery and measurement, constitute the work of the Lamont-Hussey Observatory. The late Dr. Hussey's first desire for a southern observatory was based on his interest in double stars. By 1905, when he left Lick Observatory to resume work at Michigan, Hussey himself had discovered 1,338 pairs. Since the erection of the southern observatory in 1926, nearly 7,000 new double stars have been discovered by observers there.

At the McMath-Hulbert Observatory, founded in 1932, solar research is the principal work. Its well-known motion pictures of solar prominences are the basis of much advance in modern knowledge of solar activity. At present, however, the entire staff and facilities of this observatory are devoted to the war effort.

SECRETARY OF SMITHSONIAN INSTITUTION RETIRES

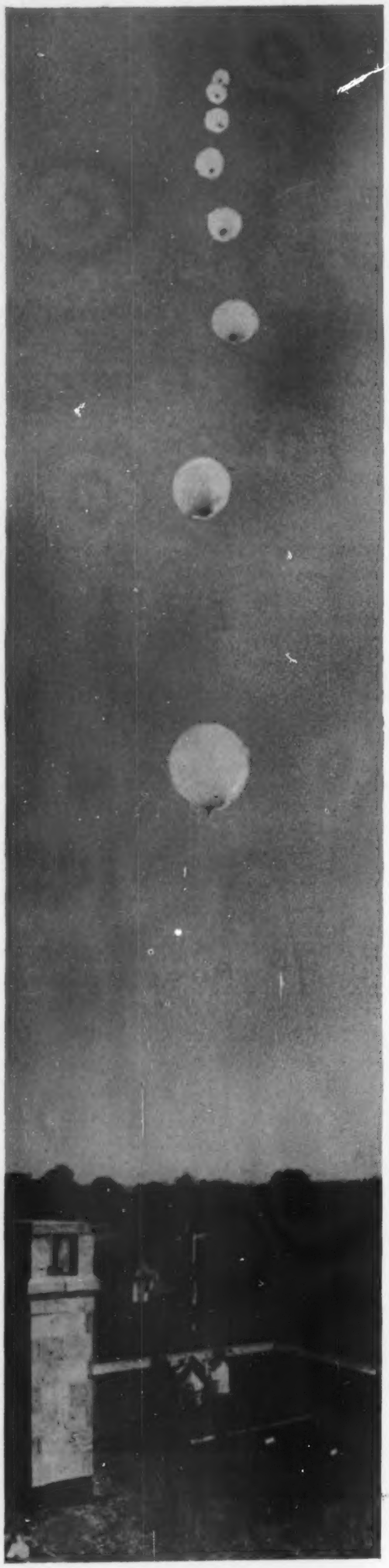
Dr. Charles G. Abbot, director of the Smithsonian Astrophysical Observatory, has resigned as secretary of the Smithsonian Institution, a post which he has held since 1928. He will be succeeded by the assistant secretary, Dr. Alexander Wetmore, biologist and head of the National Museum.

Although retiring as secretary, Dr. Abbot still retains his position as research associate of the institution and will continue his researches into the physical condition of the sun and the effects of solar radiation on terrestrial phenomena. He is well known to the public for his development of ingenious apparatus for harnessing the sun's energy for utilitarian purposes. One of his latest engines is capable of converting 15 per cent of the solar energy falling onto its mirrors into power.

THE NATURE OF COSMIC RAYS

By W. F. G. Swann

Director, Bartol Research Foundation of The Franklin Institute



PART IV

7. Electron production in the stratosphere

AND NOW, having gotten everything nicely settled, I must disturb the equilibrium by suggesting that the electrons in the upper regions of the atmosphere do not come from outside the atmosphere at all, but are born within it, born by the death of the mesotrons which themselves are born from the death of primaries which enter from outside. We shall see, however, that *these* primaries cannot be protons, but are particles of greater mass.

The evidence for this disturbing statement comes from our stratosphere observations, which have shown that a large number of the cosmic ray particles found in the higher regions of the atmosphere travel in directions making large angles — even 90-degree angles — with the vertical. This horizontal com-

A SUMMARY OF PRECEDING INSTALLMENTS

THE COSMIC atomic particles continually disrupt (ionize) the atoms of the atmosphere, rendering the air capable of conducting electricity. Cosmic radiation increases in intensity with altitude above the earth's surface and possesses power to penetrate into deep mines and to the bottoms of lakes.

The study of cosmic rays is closely linked with the fundamental building blocks of physics, which for a time were thought to be three in number: the negative electron; the proton, 2,000 times heavier than the electron but of equal positive charge; and the photon, a kind of ghost particle representing light and other forms of electromagnetic radiation. More recently, however, studies of atomic phenomena have revealed more particles, the most important of which for cosmic rays is the mesotron, a particle 200 times heavier than the electron and possessing a charge of either sign.

A high-energy particle, in passing through matter, expends energy by ionizing (ejecting electrons from) the atoms it passes. We now know that occasionally a high-energy electron may lose all or a large part of its energy in creating a photon at a suitable atomic encounter. Photons were formerly believed to confine their activities to the occasional emission of high-energy electrons from atoms. Now, however, we know that a photon of high energy possesses the power, on suitably encountering an atom, to materialize into a positive and negative electron. Mesotrons are characterized by having but a finite life. For a very slow-moving mesotron, the average life expectancy is about two millionths of a second. Mesotrons of high velocity may live longer. Ionizing the air is a mesotron's only activity.

Originally cosmic rays were thought to be high-energy photons—very short X-rays. Electrically charged particles seemed ruled out because of the energy, then considered enormous, which they would have to possess to pass right through the atmosphere and even to reach the atmosphere through the earth's magnetic field, which tends to turn them back into space. However, the discovery of the latitude effect in cosmic rays made charged particles a necessity for its explanation. The energy necessary for a charged particle to penetrate the earth's magnetic field gets less as the magnetic latitude increases. Thus more and more of the low-energy incoming rays reach the atmosphere as we travel to increasing latitudes.

However, an electron with energy sufficient to penetrate the magnetic field at the equator would have no difficulty in traversing the atmosphere, so that we should expect no diminution of intensity with altitude at the equator. This conclusion, contrary to the facts, led the author to propose that the primary rays produced secondary particles in number proportional to the primary energy, so that the number of electrons observable at high altitudes would be expected to be greater than the number at low altitudes on account of the greater primary energy at high altitudes. A maximum in the intensity would be expected at a certain altitude because, if we ascend sufficiently far, there will obviously be insufficient atmosphere above to provide many secondaries. This idea received its detailed exemplification in that process already cited in which high-energy electrons produce photons, which in turn give birth to additional electrons.

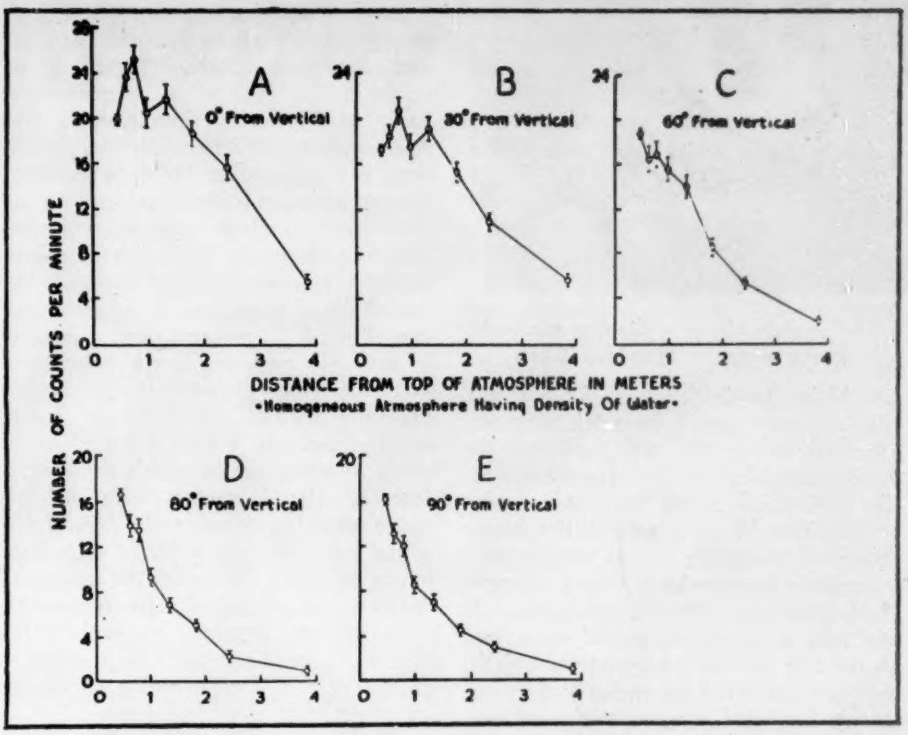
Mesotrons of both negative and positive charge have been observed to constitute a considerable part of cosmic rays at sea level and in deep mines. The very short life of the mesotron, the east-west asymmetry of cosmic rays, and the energies possessed by the mesotrons, all indicate that these are formed in the atmosphere by primary protons which appear to split up into mesotrons. These mesotrons each carry a proportionate share of the energy of the incoming proton. The mesotrons also produce, by their deaths and by occasional ionizations of atoms, electrons which accompany them at all depths of the atmosphere. There is evidence, however, that the proton is not the only primary particle which is not an electron.

Eight balloons in tandem about to carry cosmic ray apparatus high into the stratosphere. This flight was made from the roof of the Bartol Research Foundation with apparatus designed by S. A. Korff.

ponent of the radiation becomes consistently more evident as the altitude is increased. It is quite appreciable at an altitude of 40,000 feet. It becomes highly important at 50,000 feet, and at 72,000 feet our cosmic ray telescopes have shown, for the horizontal direction, readings 80 per cent of those for the vertical direction. It is true that a horizontally directed telescope receives rays from both ends so that its readings must be divided by two in order to be compared with readings for a vertical direction, but even then the horizontal intensity amounts to 40 per cent of the vertical. Of course, the effective horizontal thickness of the atmosphere at these altitudes is less than it is at sea level; but even when allowance is made for this, we can find no justification for supposing that these rays, traveling at large angles to the vertical, can have come from outside the atmosphere.

Again, if the electrons came from outside, we should expect that on account of the effect of the earth's magnetic field they would show an asymmetry in intensity with respect to azimuth, whereas our results from the stratosphere flights show symmetry in azimuth to better than one per cent, and the high-altitude observations of T. H. Johnson and J. G. Barry, performed near the equator, show no appreciable asymmetry.

If the electrons do not come from outside the atmosphere, the only reasonable origin for them is in the death of the mesotrons. Electrons born from mesotrons may be expected to be shot out with equal probability in all directions, as observed from the mesotrons, just as the fragments from a bomb exploded in an airplane would be shot equally in all directions as observed from the airplane. If the plane is moving very fast, the fragments will not appear to be shot out symmetrically in all directions as viewed from the ground, but will appear to favor the direction of motion of the airplane. The same thing happens, modified to some degree by the theory of relativity, in the case of the electrons shot out from the mesotrons. If, therefore, we are to have as much symmetry in the ejection of the electrons as is observed from our fixed frame of reference, the mesotrons concerned must be traveling sufficiently slowly. We calculate the results to be expected from the lowest-energy mesotrons produced from protons which can enter through the earth's magnetic field, but find that the electrons so produced would not, on the average, deviate enough from the vertical direction to correspond to the facts. We must have mesotrons of lower energy, that is, of lower velocity, and consequently the corresponding primaries must have lower velocities. In this case, the primaries must have greater mass than that of the proton if they are



Data obtained by the Bartol Research Foundation on the second National Geographic—U. S. Army Air Corps stratosphere flight, showing, for various zenith angles, the cosmic ray intensity plotted against the distance from what would be the top of the atmosphere if the atmosphere were liquefied and compressed to have the density of water.

to be able to get through the earth's magnetic field.

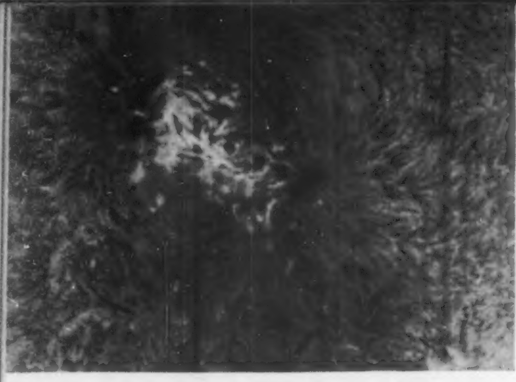
It turns out that if we assume these primaries to be singly charged helium atoms (mass equal to that of four protons), the electrons born as their grandchildren (the mesotrons being the parents) would have, in a horizontal direction, an intensity 22 per cent of the corresponding intensity in the vertical direction at an altitude equivalent to 0.1 atmosphere (53,000 feet). Such a result is in harmony with the facts. Mesotrons born with such small energies as would correspond to the velocity appropriate to the helium atoms would have for the most part a life of only about two millionths of a second. They would die before they had traveled more than about 300 meters and their offspring, the electrons, would be born within that distance of their own place of birth.

The net result of the picture at this stage is, therefore, that the incoming primary particles are protons and singly charged helium atoms. The former, by their death, give rise to mesotrons which are observed at all altitudes down to sea level and below. The electron offspring of these mesotrons are also observed at all altitudes. The helium atoms give rise, through mesotrons, to electrons which are confined to the upper regions of the atmosphere, and those yield a considerable intensity in directions inclined at large angles to the vertical. Directly an electron is formed, it proceeds to propagate its species in the manner I have already described, and in doing so, fills the air with ghosts, the photons. That part of the picture remains. We still expect the total radiation to reach a maximum intensity as we ascend to the higher regions of the atmosphere, after which it diminishes, because in the outermost regions there is nothing but the primaries. Indeed, it is possible that there may be more than one maximum in the intensity-altitude curve.

Recently, M. Schein and his coworkers have given evidence for the existence of neutral incoming particles in the cosmic radiation. How far these neutral particles, in the totality of their activities, can replace helium atoms in accounting for the horizontal radiation observed is a matter which awaits further study.

8. The origin of the cosmic radiation

THE ORIGIN of the primary cosmic rays has always been a matter of profound speculation. One of the earliest suggestions was by R. A. Millikan, to the effect that the cosmic rays arose in a process in which atoms were born in interstellar space by the coming together of the ultimate particles which play a part in their structure. On this view, the primary rays were the birth cries of the atoms. Recently Millikan has offered another suggestion in which the rays originate when atoms die in interstellar space, so that on this view they



The region above a bipolar sunspot group seen in hydrogen light.

would be the death gasps of the atoms. For my own part, I have felt that two mechanisms are available, without too much stretching of the imagination, for the realization of the energies desired.

The first of these possibilities is one in which charged particles receive their energies in the stars by changing magnetic fields such as we observe in sunspots. If we take a circular loop of wire and thrust one pole of a magnet through it, we get a current of electricity in the wire. If we keep the magnet stationary and increase its strength by suitable electrical excitation, then while its strength is increasing, a current of electricity will flow around the circular loop of wire. In other words, a changing magnetic field of force represents a region in which electricity becomes set in motion. It is on such principles that a dynamo operates.

It has long been known that sunspots are associated with intense magnetic activity. A sunspot can grow in a period of 10 days over an area many times that of the earth's surface, a magnetic field 10,000 times as great as the earth's horizontal field. While such fields are growing or decaying, there are forces which tend to accelerate any electric charges in the vicinity. It is not so much the magnitudes of the magnetic fields which count as the extent of the regions over which they exist. Thus, if in a stellar area 50 times the diameter of the earth, a magnetic field were growing at the rate at which it grows in a sunspot, then even in the initial period of that growth (in fact, during the first second of it, before the field had grown to 1/100 of the earth's horizontal field), it could give to a charged particle of electronic mass an energy comparable with that acquired under 10 billion volts. It is not necessary for us to invoke large areas of very intense magnetic activity. A star may have a comparatively mild magnetic activity all over the surface, with the magnetic field in one direction in some places and in the opposite direction in others. Then even though there may be no magnetic flux through a large area when averaged over an appreciable time, at any instant there may be for the area a small residual in one direction, all that is necessary to promote the high energy required by cosmic ray particles.

Another obvious way of creating high energies is through the operation of processes analogous to those prevailing on earth in the case of a thunderstorm. Even a terrestrial thunderstorm can realize potential differences comparable with a billion volts. Now a thundershower is simply representative of a huge electrostatic machine operating under the influence of gravity and with its energy supplied by meteorological means. We can think of situations in which a star can blow off 10 per cent of its substance in a single explosion — the supernovae — or we can contemplate the phenomena taking place in the ordinary stellar mechanisms. It is then not difficult to think of situations in which the equivalent of thunderstorms with suitable modifications of detail, and not involving actual rain, can take place in such fashion as to realize potential differences of the order of 20 billion volts or more.

In all the attempts to explain the origin of cosmic ray particles, one has to remember that a planetary body cannot go on emitting particles of one sign forever without bringing into play electric forces which would combat the emission. Again, even in interstellar space, we cannot permit the existence of particles all of one sign. For then, with the cosmic ray intensity comparable with that on the earth, the space density of the cosmic ray particles, though extremely small, would nevertheless be sufficiently great to require potential differences of the order of a million million million volts between points a light-year apart. Thus, even though the particles active as primary cosmic rays may all be of one sign, they must exist surrounded in interstellar space by particles of opposite sign, even though those particles may be of low energy.

An attractive theory of cosmic rays, suggested by the Abbé Lemaitre, is founded on the idea that all the matter in the universe was collected together at one time in one place at what we may call the center of nowhere, and that it all blew up. On this view, cosmic rays are the atomic dust, but they belong to the same family as the bigger things of the universe, the meteors, the planets, the stars, and so forth, so that even the great galaxies of space are in a sense some of the cosmic rays.

In deciding upon a mechanism suitable for the realization of cosmic ray energies, the difficulty is not so much to find a mechanism which is reasonable as to decide between the various possibilities. The process must be bound so definitely and inevitably to an accepted stellar or other cosmic process as to leave no doubt, within the realm of reason, and must enable us to say not merely that cosmic rays *might* be produced in such and such a manner, but that they *must* be so produced.

TWO OF the questions which are most frequently asked by the layman are: What is the value of studying cosmic rays? Can we harness and use the cosmic ray energy? I usually answer the first question by asking another: What is the use of a microscope in medicine and surgery? With a microscope one cannot cure a disease or mend a bone. No, but with a microscope we can learn much concerning disease and the technique of surgery. And so, in the cosmic rays we are presented with activities bound up in most rich and basic degree with the fundamentals of the structure of atoms and molecules. Science has reached a stage in which it has largely exhausted the potentialities for progress inherent in a general empirical knowledge of the properties of matter. We have reached a stage in which the questions remaining to be answered dig down to the fundamentals of atomic structure. If ever we are to realize in practical degree such dreams as the utilization of atomic energy, it will be through the aid of greater knowledge acquired by the study of such phenomena as those met with in the cosmic rays.

With regard to the cosmic ray energies themselves, while the energy *per unit mass* of each individual ray is great, the actual energy of a ray is relatively small, and the total energy of all the rays falling upon us is not very large. A proton cosmic ray, such as could just reach the earth through the magnetic field at the equator, a ray having an energy of 15 billion electron volts, would in actuality have energy sufficient only to lift a pin's head about 1/100 of an inch. The total mass of all the cosmic rays falling in one second upon the surface of the earth amounts to only about one millionth of one millionth of an ounce, so that in 30,000 years the weight of the cosmic rays would only increase the mass of the earth by about an ounce.

Speaking in general terms of the energy of cosmic rays as compared with that of sunlight, I have likened the effect of the cosmic rays to that of dropping upon one's head a particle very much smaller than a pinhead once a minute from a distance of a mile, whereas sunlight is like dropping upon one's head a ton of bricks per second from the distance of a foot. The total power supplied by the cosmic rays to the earth is about a million kilowatts. That would be a large amount of power for anyone to pay for, but it is very little as things go in nature. The energy falling on the earth from the sun is about 100 million times as large, so that he who wishes to tap the power of the universe will do well to look first to that old father of all life, the sun, rather than to those mysterious wasps of space, the cosmic rays.

THE END

THE ASTEROIDS

Last year the Monthly Notices *of the Astronomical Society of South Africa carried a series of articles on the minor planets. By courtesy of the society and the authors, the third and fourth articles are republished this month; the first two appeared in last month's issue of* Sky and Telescope. *The more mathematical nature of a fifth article, "The Equilibrium of the Trojan Asteroids," by W. P. Hirst, and current printing limitations prevent our including it here, but we shall be glad to make up mimeographed copies if a sufficient number of requests are received. If you wish to know a geometrical proof of why the equilibrium condition exists (not including proof of the stability of the system), please send us your request before September 15th.*

The Orbits of the Minor Planets

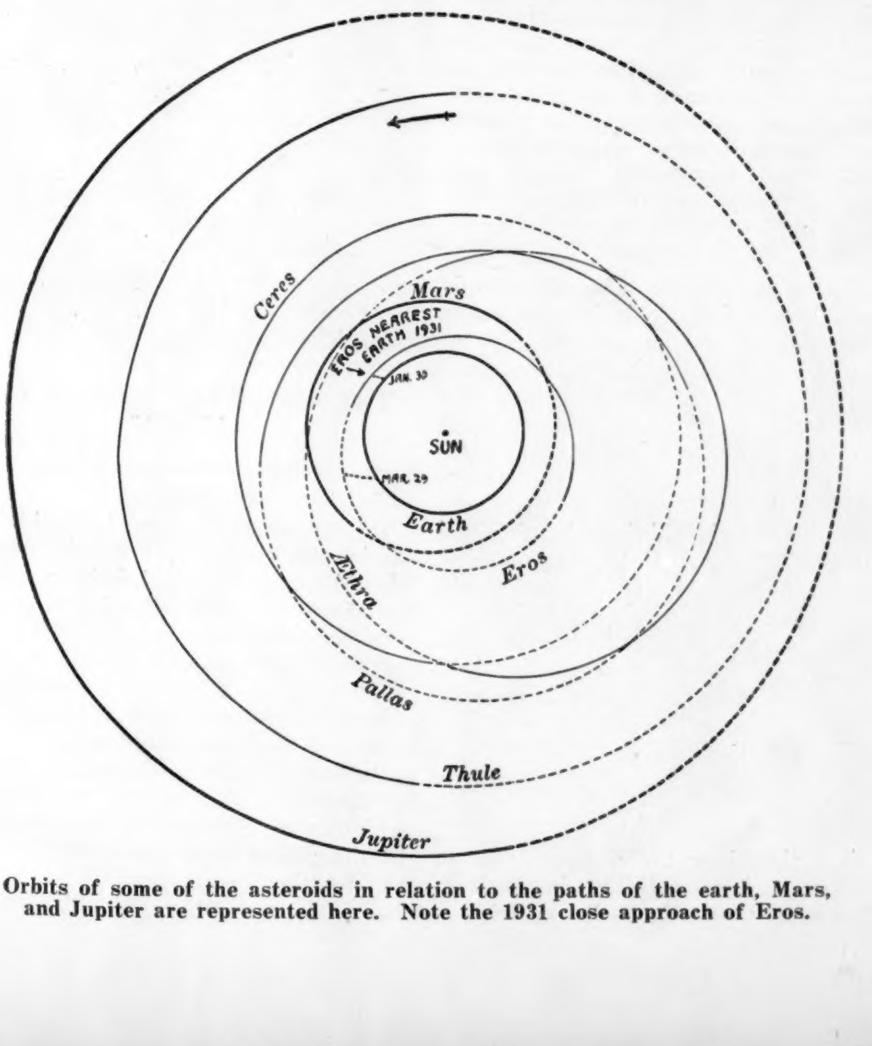
By J. Jackson

His Majesty's Astronomer at the Cape

THE computation of the orbits of the minor planets is a problem of some difficulty. This difficulty is principally due to the fact that these bodies may approach Jupiter, the most massive of the major planets, more closely than do the other major planets. Amongst the major planets the problem of greatest difficulty is the computation of the mutual perturbations of Jupiter and Saturn, but these are small in comparison with those suffered by the minor planets. The difficulty is increased by the high eccentricity and high inclination of the orbits of many of the minor planets. Consequently although the computations for the major planets give their positions correct to about one second of arc, there are many asteroids which depart from the computed positions by a degree—due partly to a poor original orbit and partly to neglect of perturbations. It is no wonder that someone once proposed that it be "considered a crime punishable by fine and imprisonment to discover any more."

The great labor of calculating the positions of the minor planets has been carried on by the German Rechen-Institut (Office of the Berlin *Jahrbuch*) with some assistance from willing workers elsewhere. For each of the 1,500 asteroids, an ephemeris is calculated for a month or so near the time of opposition and these are arranged in order of the time of opposition in a special yearly publication called *Kleine Planeten.* If, therefore, you are exposing plates near opposition and find a planetary trail, it is not necessary to hunt through the positions of all the known minor planets but only a dozen or two near opposition. As the error in the predicted place is most likely to be along the orbit, the error in declination corresponding to a minute of right ascension is tabulated. This greatly assists in the identification of known planets.

The number of known minor planets gives about four for each degree of heliocentric longitude, say two for each degree of geocentric longitude in opposition. These extend over a wide range in latitude and may be so far distant that they can hardly be expected to show on the plates taken with the usual exposures. Hence a plate covering an area 5°x5° will often not contain any known asteroids. Many minor planets found on photographic plates cannot be identified with known planets and cannot be followed up because of bad weather or bright moonlight, but the positions are tabulated for use at a later date, when the asteroid has been rediscovered and its orbit computed.



Orbits of some of the asteroids in relation to the paths of the earth, Mars, and Jupiter are represented here. Note the 1931 close approach of Eros.

The Trojan Group

By H. E. Krumm

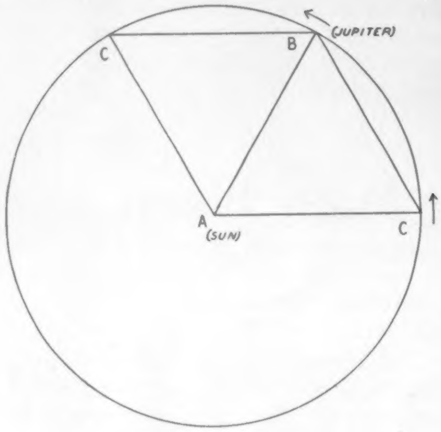
Astronomical Society of South Africa

THE TROJAN group constitutes perhaps one of the most interesting sets of the minor planets. In order that the interest attaching to this set or group might be fully appreciated, it is necessary that we understand the mathematical background which anticipated their discovery.

Astronomical calculations have become a byword — almost everyone knows just how intricate a good many of them are. Everyone, at some time or other, has heard that the worst of them deal with mysterious things

called "perturbations." The real trouble arises from the fact that astronomers wish to predict the motions of the heavenly bodies with the same degree of accuracy as that with which they can measure them. This is a comparatively easy matter when only two bodies are being dealt with at a time, such, for instance, as a double star, the two components revolving round their common center of gravity without being perturbed by external influences. Under their mutual gravitational attractions they pursue a fixed elliptical orbit, returning to the same place at exactly equal intervals of time. Their relative positions at any given instant can be calculated by anybody possessing knowledge of trigonometry. With three bodies present, however — say for example, the sun, Jupiter, and Saturn — the problem becomes extraordinarily complex. Competent mathematicians after a century of investigation have come to the conclusion that if any general formula for the three-body problem could be obtained, it would be so intricate that it would be of no practical use at all for numerical calculations. Fortunately the position is not wholly beyond redemption, for while a general formula is impracticable, certain solutions have been obtained for special cases. One such special case concerns the Trojan group of minor planets.

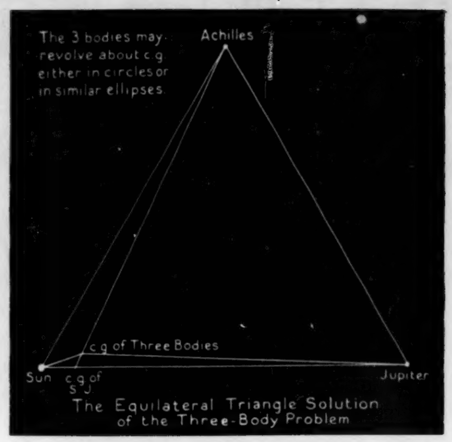
Consider two bodies A and B, each having a finite mass, and a third body C, whose mass is infinitesimal; in other words, it is so small that it does not appreciably disturb the motions of the first two, though its own motion is controlled by their attractive forces. Suppose that the two bodies A and B are revolving round their common center of gravity in circular orbits, and further, that the third body happens to be placed in the plane of the orbit of the first two, in such a position that all three bodies lie at the vertices of an equilateral triangle. Under these conditions the three bodies will continue to move in the same plane locked forever at the



vertices of the equilateral triangle. (Actually two such triangles are possible, as may be seen from the figure.) An observer situated over the center of gravity of the system and sharing in its motion would see all three bodies apparently at rest.

One of the interesting points about this equilateral triangle solution is its stability. If some momentary external force happens to draw the third body slightly away from the critical point at the vertex of the triangle, it will not recede indefinitely from it but will describe a small oscillation about that point. The system will not be broken up, at least not for a long time.

When Lagrange first proposed this solution in 1772 no celestial example was known. He took, however, as a hypothetical case an asteroid moving in such a way that its distances from Jupiter and the sun remained the same and equal to the distance separating those two bodies. In other words, Jupiter and the sun represented the bodies of finite mass and the asteroid the third, or infinitesimal body. The large discrepancy in mass between the sun and Jupiter would cause the center of gravity to be very close to the sun, resulting in the distances of Jupiter and the asteroid from the center of gravity being very nearly the same. Time has fully justified this assumption, for at least 11, perhaps 12 such asteroids have been discovered during the last 37 years. They are known as the Trojan group, since they bear the names of heroes that won immortal fame in the Trojan War; they are as follows: Achilles,



Patroclus, Hector, Nestor, Priamus, Agamemnon, Odysseus, Aeneas, Anchises, Troilus, and Ajax. Six are east (precede) and five are west (follow) of Jupiter. Achilles was the first to be discovered in 1906 by Max Wolf, of Heidelberg. The writer is unable to ascertain whether Wolf was searching one of the vertices of the two triangles for a Trojan or whether it was just a chance discovery of "another asteroid."

None of the Trojans is situated exactly at the vertices of the equilateral triangles. They are all, however, near one of the critical points, within some 20 degrees as seen from the sun, and their orbits are presumably such that each asteroid performs small oscillations about one of the critical points, and will continue to do so indefinitely.

It was pointed out above that this particular solution of the three-body problem represents a stable configuration. It should be mentioned, however, that the configuration is only stable so long as the mass of one of the finite bodies has less than 1/26 that of the other. Jupiter's mass is less than 1/1,000 that of the sun so the condition for stability is satisfied.

An asteroid is registered as a trail when a camera is set up to follow the stars.

THE ROTATION PERIOD OF SATURN

A Correction

In *Sky and Telescope* for June, 1944, on page 15, step 4 should include this statement: "This figure should again be divided by two in order to account for the fact that we are observing the Doppler effect of *reflected* light from a moving body." This was called to my attention by Dr. J. H. Moore, of Lick Observatory. This correction increases my value to $20^h\ 14^m.4$. However, using a picture sent to me by Dr. Moore, with the slit definitely on the equator of the planet, I obtained $9^h\ 33^m$ for the rotation period.

HELEN B. PETTIT

Amateur Astronomers

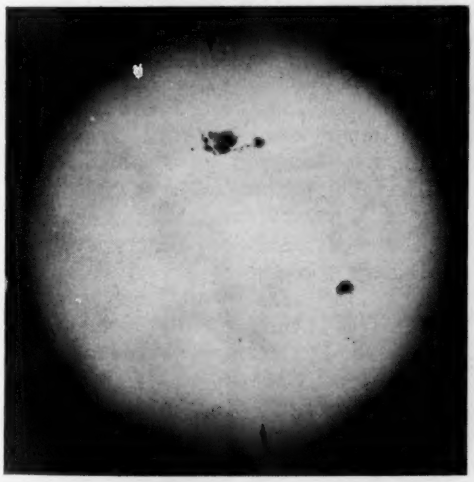
EXPLORING THE HEAVENS
With a 2-inch telescope

By Lester Sussman

EXPLORING the vast wilderness of the universe with a small telescope is a pioneer adventure all its own. The sunspots, the moon, and the planets are the outstanding scenery of the sky, while the stellar universe, too, has its gems for the small instrument.

The Pleiades in Taurus and the Beehive in Cancer are open clusters showing swarms of individual stars. The Hercules globular cluster shows as a round mist. Visible nebulae are found in Orion's sword, in Andromeda, and in Sagittarius. The Andromeda galaxy looks like an oval fog. There are many colored multiple stars (mostly gold and blue pairs such as Albireo in Cygnus) which add beauty to the glittering worlds of the universe.

The lunar world shows an inexhaustible maze of selenographical wonders. Most books mention only a few sights, such as the moon's craters, the rays extending from Tycho, and so on. But there are also rippling serpentine ridges in the maria, craters half-dissolved (Fracastor), canyons that dwarf our own (Alpine valley), filled-up craters (Wargentin), crevasses, bubbles, and many other formations. In the telescope the moon appears like carved work in alabaster.

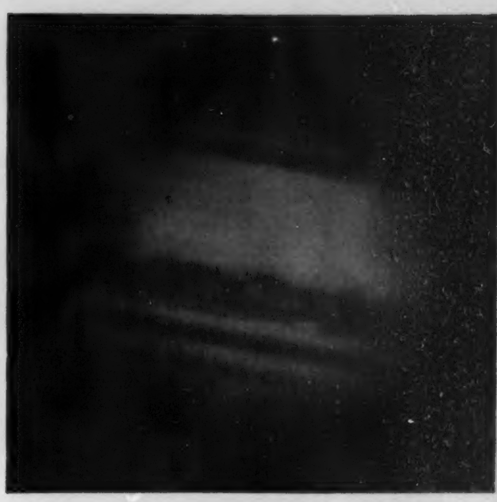


Of the planets, Saturn now has its ring wide open, beautifully observable in a small glass. Venus may be seen in all of its phases from silvery crescent to small disk. On Jupiter, the giant planet, a horizontal belt can be seen across its oval, cream-colored face. Alongside of it are the four bright satellites, changing positions each night, each hour, sometimes passing one above the other and sometimes hiding behind Jupiter or appearing all on one side of it. Besides its pink color, Mars shows its major markings during opposition. During its close approach of 1941, Syrtis Major and Mare Cimmerium were visible in a 2-inch telescope; in Mars' winter season the pole cap may be seen.

By far the greatest wealth of changing scenery is found in sunspots, which are excellent objects for a small instrument. The sun is a moving picture, with spots growing, dwindling, splitting, multiplying, day by day. Some develop complex networks of penumbrae, and some when rotating to the limb of the sun are surrounded by faculae appearing like flecks of foam on the darker edge of the sun. Some sunspots return through several rotations. (Extreme care should be used when observing the sun to avoid the terrific heat and blinding light of its focussed image; if no genuine solar eyepiece is available, its image should be projected through the eyepiece onto a stiff paper or cardboard.)

Interest in sunspots lies not only in their telescopic appearance but in the

(Continued on page 19)



Observers with small telescopes can easily see the belts on Jupiter (above), Saturn's rings (below), and can watch the progress of sunspots (left, below) across the solar surface.

METEOR PICNIC

Star Dust, bulletin of the National Capital Amateur Astronomers Association, announces August 12th as the date for a meteor picnic for members and any interested amateurs in the Washington area. The picnic is to be held at Montrose Park in Georgetown on R Street between 30th and 31st, three blocks east of the Wisconsin Ave. car line and not far from the Q Street bus. Those wishing to hike a mile through a beautiful section of Rock Creek Park are to meet at the southwest corner of Connecticut and Calvert Streets at 6:45 p.m. Otherwise meet in the park at 7:30.

This evening, near the maximum of the Perseids, should provide plenty of activity for meteor counters and plotters. For further information, call C. Herreshoff, Emerson 0992.

An observation picnic was scheduled for the National Capital amateurs on Saturday evening, July 22nd, at the Palisades Field House, on the Glen Echo car line. Those who could were to bring their own telescopes. Two outdoor fireplaces and the kitchen in the House were at the disposal of the amateurs; firewood, coffee, and sweet corn, if obtainable, were to be procured by the entertainment committee. The meeting was announced for 7 p.m. rain or shine, at the Field House.

MABEL STERNS
N.C.A.A.A.

AMATEUR ASTRONOMERS ASSOCIATION
New York City

Plans have been announced for the annual Labor Day weekend at Blue Mountain Reservation, Peekskill, N. Y. This will be the sixth visit of the society to this scenic location where, weather permitting, conditions are ideal for astronomical and outdoor activities.

The program calls for informal sports by day, including hiking and swimming, and for stargazing and related astronomical events at night. A number of telescopes are usually available, but binoculars and richest fields should be brought along, also cameras.

Members are requested to make their reservations at once, as the Trail Lodge, which is reserved for the exclusive use of the society, accommodates only 30 persons. Details may be obtained from G. V. Plachy, secretary, Amateur Astronomers Association, Hayden Planetarium, New York 24, N. Y.

Members and guests of the American Astronomical Soci

PHILADELPHI

By I. M. Levitt, *Fels Plana*

AMID surroundings historical and astronomical the 72nd meeting of the American Astronomical Society was opened in Philadelphia on June 28th, with about 100 members and guests present. As a vice-president of the American Philosophical Society, Dr. Harlow Shapley welcomed the astronomers to the building adjoining Independence Hall; then, as president of the American Astronomical Society, he called upon Dr. W. F. G. Swann, secretary of the Philosophical Society, who added his welcome.

One of the papers on the morning program was by W. F. Swann, of Eastman Kodak Company, and son of the cosmic ray expert. He described a few recent modifications in astronomical photographic emulsions, but his main theme was the contribution that spectroscopic materials, supplied before the war chiefly to astronomers and physicists, were making to industry.

"Probably the largest users of spectroscopic plates and films at the present time are the industrial spectrographers," Mr. Swann said. "In some large steel plants it is not uncommon to use 100 dozen 4x10 plates a week. Spectrographic analysis is used as a direct control on production in many of the large metal industries. The chemist can, of course, do this analysis, but whereas it takes him several hours to determine the percentages of the various constituents, the spectrographer takes only a matter of minutes. The processing of the plate, including drying, takes only 3½ minutes, and an analysis can be completed in less than 15 minutes. A tremendous saving in materials, time, and money is effected, particularly in the larger companies, because analysis can be made before the metal is cast."

Dr. Charles P. Olivier, of the University of Pennsylvania, briefly reviewed the history of the American Meteor Society from its inception in 1911 to the present day. He disclosed that over 370,000 observations have come into the offices of the society at the Flower Observatory, and that from these at least a thousand real radiants had been worked out. He told of the many professional astronomers who had begun as meteor observers, and stated that the entire collection of observations and reductions had been willed to The Franklin Institute where this data may be available to the future generations of astronomers.

Heights and orbits of 95 fireballs have been computed; also the heights of some 500 other meteors, largely those observed during the Leonid maximum of 1931-1935. The society has several hundred more-or-less regular observers; originally it had nine members. Dr. Olivier requested the astronomers particularly to report telescopic meteors, stating that the small time taken from a regular observing program to record a telescopic meteor might well be worth the results obtained.

After the morning session, the society adjourned to be photographed in the courtyard of Independence Hall, near the site of David Rittenhouse's 1769 transit of Venus platform. This is the same platform from which the Declaration of Independence was read to the public for the first time. Visits to nearby points of historical interest occupied the time until the business meeting in the afternoon.

A short session for papers was followed by a teachers' conference, presided over by Dr. Charles H. Smiley, of Ladd Observatory. After a discussion concerning the teaching of navigation and methods of emergency navigation, some attention was given the problem of what to include in and what to omit from courses in elementary astronomy. There was considerable difference of opinion concerning a proposal that historical material be cut to a minimum to make room for the study of modern methods. The teachers' conference concluded with a panel discussion on the place of post-war astronomy in a liberal arts college, this subject being taken by Dr. O. L. Dustheimer, John Carroll University. The discussion was led by

ASTRONOMERS

Our race has want of sages such as these,
Whose measuring-rods are light-years, and who say
That points a million trillion leagues away
Are only as our next-door galaxies.
O stalwart vision of immensities
That placidly can tabulate and weigh
Star-streams and clusters, hoping for a ray
Of light . . . perhaps in coming centuries!

Such reach and lift have magic for a world
With eyes down-turned to scan the oozing soil.
For if we saw the eon-bridging Whole
Where suns like wind-blown glints of dust are swirled,
How splash in blood, or crawl for golden spoil,
While round our heads the orbs and ages roll?

STANTON A. COBLENTZ

(From "The Washington Star")

al Society at the 72nd meeting in Philadelphia, June 28-29, 1944.

PHIA MEETING

Planetarium, The Franklin Institute

Dr. T. G. Mehlin, of Williams College.

The society dinner was held at the Benjamin Franklin Hotel. After-dinner "speeches" consisted of papers from the regular program and after these the society joined the Rittenhouse Astronomical Society at the Fels Planetarium, where they formed an enthusiastic expedition on "A Trip to the Moon."

From the way the members remained in the planetarium chamber after getting back to earth one gathered that the trip was much enjoyed, or perhaps most of them were trying to solve the mysteries of the planetarium space ship.

As guests of the Rittenhouse Society, the astronomers had refreshments in the locomotive room of The Franklin Institute. There they rode in the cab of "60,000," one of the largest locomotives in the world; while others took a look at the moon through the Zeiss refractor on the roof.

Several of the papers on Thursday morning aroused a great deal of discussion. In what he stated was a determined effort to do away once and for all with the statement, "If the sun were to become a nova the earth would be vaporized," Dr. Dean B. McLaughlin, of the University of Michigan Observatory, presented computations to show that only the surface layers of the earth would be melted and probably boil for less than a month.

A planet of the same mass, size, and composition as the earth is assumed at a distance of one astronomical unit from a typical nova of absolute magnitude —7. This maximum is of brief duration, and an assumed exposure of the planet to the radiation of a star of luminosity 100,000 times the sun's for 10 days is considered a fair test. The nova is given the further benefit of the doubt by neglecting reflection and radiation from the planet.

Dr. McLaughlin finds the total energy received by the earth would be 3.8×10^{27} calories, or only 0.6 calories for each gram of its total mass. This would heat the entire earth's crust (not the interior) through only 300° centigrade, but low heat conductivity would confine the effect to a much thinner layer. This layer, about 12 kilometers thick, could be maintained at the boiling point of silica, about 2,500° absolute, by a nova of bolometric absolute magnitude —4.7. The average nova drops to this luminosity within a month or so after maximum, and after that time no further evaporation of surface rock would occur.

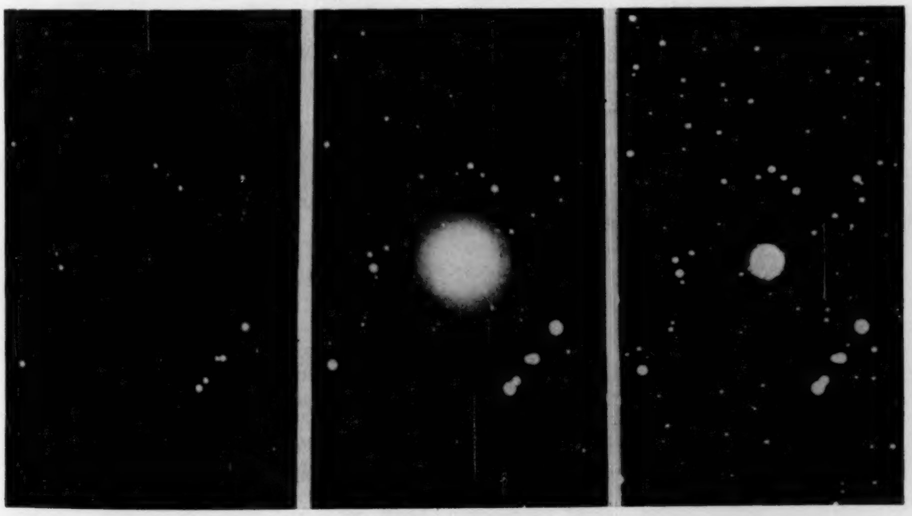
"Evidently," the nova expert said, "the planet would come through the outburst very drastically altered superficially, but essentially intact as regards its total mass. It appears even probable that the continents and ocean basins would not suffer extensive changes of height and depth, respectively."

The discovery of eight stars of remarkable redness, one of them showing 500 times as bright on red as on blue photographic plates, was reported by the Mexican astronomer, Guillermo Haro, of Tonanzintla Observatory, now working at Harvard. His method gives promise of revealing more stars of the same type and will be described in the reports of papers in this magazine next month.

Two other representatives of Latin America presented papers at the meeting. They were Carlos U. Cesco, of La Plata, Argentina, and Jorge Sahade, of Cordoba, Argentina, both describing results of their recent work at Yerkes Observatory. Senor Cesco told of spectroscopic observations of the eclipsing variable BD Virginis, and Senor Sahade presented similar results for the star AR Monocerotis.

The international character of the meeting was further emphasized by a paper on globular clusters presented in person by Dr. Helen Sawyer Hogg, of the David Dunlap Observatory, Toronto, and by two papers on spectra sent from the Dominion Astrophysical Observatory at Victoria, B. C.

Although the meeting was officially concluded with the Thursday morning session, many of the members took advantage of the opportunity to visit one of the nearby observatories, whose directors graciously extended invitations to all comers.



Three stages of the outburst of Nova Pictoris in 1925.

BOOKS AND THE SKY

BASIC MARINE NAVIGATION

Bart J. Bok and **Frances W. Wright.** Houghton Mifflin Company, Boston, 1944. 422 pages. $4.50. Kit of Practice Materials, $1.70.

DR. BOK and Miss Wright have written into this book the methods of exposition they developed while teaching a series of courses for the navigators of the Army Engineer Amphibian Command, to whom the volume is dedicated. The influence of the authors' contacts with the Amphibian Command and with the U. S. Coast Guard is reflected not only in the presentation but as well in the abundance of suggestions and comments on common-sense procedures for use in emergencies or when dealing with inadequate navigational data. It is this feature which should appeal particularly to those obliged to pilot in poorly charted waters or to land on strange beaches.

The first four chapters introduce the student to the responsibilities of the navigator and to the tools and navigational aids with which he will work. The study of the buoyage system, charts and chart symbols is facilitated by illustrative matter in the **Kit of Practice Materials** accompanying the book. The kit also contains a course protractor, star charts, and a variety of items of use in working out sample problems.

The seasoned navigator will probably skim these chapters, but in the fifth and sixth is a discussion of the magnetic compass, its compensation, errors, and use, which will be of interest both to the novice and to the practicing navigator whose experience is something less than extensive. The content of these chapters is sufficient to enable anyone to obtain satisfactory results from his compass.

Chapter 7, "Tides and Currents," appears to the reviewer to be one of the most useful in the book. Following an explanation of the causes of tides, the subjects of tidal and current predictions, use of tables, and correction of courses are carefully explained with the aid of numerous examples and extracts from the tables. The navigator who masters this chapter will be certain to extract the maximum possible information from his tide and current tables. The section on "Making One's Own Tidal Predictions" is worth the attention of those venturing into waters for which tables are not printed.

The emphasis on practical considerations continues in the chapter on piloting. All the customary tricks of the trade are explained, but the reader will also find many hints which may save him the embarrassment which arises from failure to follow the dictates of sound practice. Considering the exigencies of wartime operations, it would seem that more encouragement might have been given to the use of tangents and bearings on natural features. Although these are of limited accuracy, they are frequently all that is available. The navigator may well keep his own sketchbook showing the appearance and location of headlands and other landmarks that have assisted him in recognizing landfalls and making port. Such a record was invaluable to the reviewer during two years of operations in poorly charted waters. The future navigator should always keep in mind Conrad's words, "A pilot sees better than a stranger, because his local knowledge, like a sharper vision, completes the shapes of things hurriedly glimpsed . . . . He recognizes because he already knows."

Dead reckoning, the simpler aspects of the sailings and of the maneuvering board occupy two chapters.

Chapter 11, "Marine Meteorology," should incite the reader to try his hand at interpreting local weather conditions and predicting changes to come. As in other chapters, the photographs and diagrams are good.

The next six chapters are devoted to the sextant, the chronometer, and to celestial navigation. In general, everything has been pruned from the customary pre-war treatment that is not required for the intelligent use of H.O. 214 for line of position and azimuth sights. In common with authors of other wartime texts on the subject, Dr. Bok and Miss Wright have concluded that ". . . sound navigators can be trained without the extensive theoretical background in mathematics and astronomy formerly thought necessary." Thus, a knowledge of spherical trigonometry is not required.

The historical background of the line of position is recounted briefly, and the customary meridian and Polaris latitude sights are treated fully, but apart from this, emphasis is placed on H.O. 214. The compact treatment leaves space for star diagrams and a description of the constellations as seen from several latitude belts throughout the year.

Because of the small size of the necessary tables, Ageton's and Dreisonstok's methods are recommended especially for their value in lifeboat navigation. Ageton's principal table is reproduced in full in the back of the book.

Finally, Chapter 18, on "Navigation in Emergencies," contains a fund of suggestions, which, if applied in preparation for and during an enforced lifeboat voyage, may mean the difference between success and failure in making land. The chapter will be equally useful to the yachtsman who finds his usual navigation gear damaged by a storm.

At the end of the book are answers to the 150 problems scattered through it.

When the day arrives upon which the

picture of the Higgins tank lighter on page 3 can be replaced by one of a cabin cruiser, the yachtsman will find this volume as well adapted to his needs as to those of the wartime navigator. The reviewer recommends it strongly to the attention of both.

FREEMAN D. MILLER
Lt.-Comdr., USNR

WORLD WIDE PLANISPHERE

William H. Barton, Jr. Addison-Wesley Press, Inc., Cambridge, Mass., 1944. Four charts; four latitude masks; tables and data. $2.50.

WORLD WIDE PLANISPHERE For Finding and Identifying Navigation Stars and Constellations From All Latitudes—North or South—Throughout the Year. This is the complete title of this publication as it appears on the cover thereof. A few moments' inspection suffices to show that the author has succeeded in producing a universal device of greater simplicity than most so-called "star finders," by making a multiplicity of planisphere masks and charts.

The four masks are for latitudes 20°, 40°, 60° and 80°, and may be used on a chart centered on either the north celestial pole or the south celestial pole. This takes care of the world-wide feature as well as the time of year; the navigation stars receive extra attention, however, on two charts of their own. In other words, there are two charts centered on the north celestial pole and two centered on the southern.

On the charts devoted to the navigation stars, the only names appearing are those of the 55 stars listed in the **Nautical** and **Air Almanacs;** not even their constellations are named, although all the constellations and their principal stars are shown. In addition to the fainter, dotted lines joining the stars in a constellation, heavy lines on these charts join the navigation stars into larger groups in various regions of the sky. Thus, Regulus, Alphard, Al Suhail, and Miaplacidus are so connected. Tables of the navigational stars and their magnitudes and positions are reproduced from the **Air Almanac,** and 110 additional stars are included from the **Nautical Almanac.** Constellation and star-name pronunciation lists are also included, and there is a table of planet positions from 1943 to 1952.

On the charts devoted to the stars from what we might call the amateur astronomer's viewpoint, constellations are named and not stars, except that Greek letters are given for the more important stars in each group. Keeping star names off these charts avoids considerable confusion which might otherwise result from the comparatively small scale and the planisphere projection.

It is this necessary projection, crowded at the pole and sprawled out at the equator, which produces the two faults common to all planispheres: constellations near and below the equator are considerably distorted, and azimuths are extended along one part of the horizon and crowded in the other. However, Mr. Barton has taken great care to show in large type on each mask the location of the cardinal and intercardinal points of the horizon. The distortion of the constellations does not interfere to any appreciable extent with their identification.

Perhaps special stress should be laid on this point: no matter where you or your buddy or your overseas friend may find himself, north, south, east or west, he can reproduce the night sky for his location and at any time of the year by combining one of the World Wide Planisphere masks with the proper chart turned to the right position. It can be done in 10 seconds by a young youngster, as this reviewer has observed in an actual case.

Two 20-loop hinges, good printing on very heavy 10x10-inch stock give promise that the planisphere should well withstand the 10 years of use anticipated by the table of planet positions.

C.A.F.

REQUEST FOR BACK NUMBERS

TO FILL an unprecedented number of requests from our subscribers for certain back issues which we are unable to supply, the circulation department of *Sky and Telescope* will pay the cost and postage for any of the following numbers in reasonably good condition:

Vol. I, Nos. 3, 4, 6, 8, 11, respectively being January, February, April, June, and September, 1942.

These should be sent flat in an envelope, preferably with cardboard, to Circulation Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 30c a line per insertion, 7 words to the line. Minimum ad 3 lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

GLEANINGS FOR A.T.M.s

Simple Setting Circles for Amateur Telescopes

AMATEUR astronomers sometimes fail to view highly attractive celestial scenery simply because they lack means for directing their portable telescopes toward objects invisible to the naked eye. The hunt-and-find system of sighting the Dumbbell nebula or the Hercules globular star cluster, for instance, is very tiresome and often unsuccessful; most practiced observers devise better methods, a few of which are mentioned here.

Whoever has access to a good atlas or tables giving locations (in right ascension and declination) of various stars and other objects is far from helpless. The field of view of the eyepiece should be known: since Alcor is 0°.2 from Mizar, if one of these stars is brought to the edge of the field and the other seems to lie 1/5 the distance to the opposite edge, then the diameter of the field, in our example, is close to 1°.

Further, assuming an equatorial mounting, which is the only practical kind for all observing but comet-seeking, the polar axis of the telescope should be set approximately in the meridian and pointed as near as possible to Polaris. It is sometimes surprising how "approximate" this may be and yet bring fair results. In his earlier years, the writer used to carry his 3-inch refractor out into a vacant lot and orient it on Polaris each time it was to be used. The entire mounting was revolvable horizontally (in azimuth) on the tripod head so that it could easily be set approximately in the meridian. The only adjustment usually made after the tripod top was leveled was the pointing of the polar axis toward the north star. Sometimes, by means of the tables in the **Nautical Almanac**, the azimuth or angular distance of Polaris from the meridian (at present never more than one degree) was calculated for the time of the setting up and proper allowance made by observing Polaris with reference to the cross hairs in the finder of known angular field width.

With no further instrumental aid or improvements, let us attempt to find M27, the Dumbbell nebula. Its position is roughly $19^h\ 57^m$, $+22°.5$. We need a nearby star to start from: Gamma Sagittae is near and easily seen. Its position is $19^h\ 56^m$, $+19°.3$; thus the nebula is 1^m east and 3°.2 north of the star. When our watch reads an even minute, the star is brought to the center of the field, but this is over three degrees too far south for the nebula. Therefore, choosing some faint star—there is usually one near the edge of the field—we "move" it to the opposite edge to sweep out 1° of declination while moving the telescope. We make three of these 1° moves and then estimate 0°.2 more, bringing the instrument to the proper declination for the nebula. At the end of one minute from the time the star was centered, the nebula should drift close to the center of the field. Had the right ascension of the nebula been 10^m greater than that of the star, then it would have been necessary to wait 10 minutes for its centering. The difference between solar and sidereal minutes may be disregarded completely in such rough and short-time settings.

However, the Dumbbell nebula is so conspicuous in even a 3-inch telescope that no time or right ascension calculations are really needed even were the nebula considerably farther than 1^m from the guide star. The change in right ascension can be made simply by swinging the telescope on the polar axis in the proper direction until the nebula appears. This will, of course, work equally well if the object sought is west of the star.

The operation is much more conveniently performed if a cardboard protractor and a pointer are mounted on the declination part of the telescope mounting. The first declination circle used by the writer on his 3-inch was a cardboard protractor 8 inches in diameter and graduated in half degrees. It was so large that it would strike certain parts of the mounting when that was turned too far; the circle was taken off each time after using. Later, a 5-inch circle was made of two 180° protractors glued onto a thin piece of plywood and shellacked. A carefully cut hole in its center allowed it to fit very tightly over the 3-inch metal ring on the stationary part of the declination axis.

Against this stationary ring, a similar rotating ring produced friction when the telescope was turned on this axis. A pointer was mounted on the rotating ring. These rings were accurately machined, as they undoubtedly are on all factory-made mountings.

After the telescope was approximately oriented, the first step was to set it on a guide star not far from the dim object to be observed. With the aid of a dimmed flashlight, the pointer was adjusted so as to read the declination of the star to the nearest tenth of a degree. Then the telescope was moved on the declination axis until the pointer indicated on the circle the declination of the object sought. All that remained to do was to look into the eyepiece and swing the telescope on the polar axis until the object floated merrily into view. With good orientation of the polar axis, the object could be found even when two or three hours in right ascension from the guide star, and poor orientation was sufficient when star and object were not far apart.

Later, this little telescope was permanently mounted and very carefully oriented. Then it was seldom necessary to check the readings on a star as everything usually remained in place. A small lens was fastened on the rotating part with the pointer to facilitate the reading of the circle. An hour-angle circle was later added but seldom used as known objects could be located so easily without it. Thus, if the Hercules cluster, M13, was wanted, the telescope was pointed to its general location, the declination circle was set at $+36^\circ.6$ and the instrument was rotated on the polar axis until the cluster came into view. It might not come exactly across the center of the field, but it was somewhere in it.

Even with the addition of the plywood ring and the little lens, the entire setup cost hardly more than one dollar. The writer knows of two companies that now have for sale transparent composition circles of 6-inch diameter graduated to half degrees on beveled edges and of splendid accuracy. Both sell for $2.50. Each has two circles of figures around the circumference, but one is a little better than the other in that the outside set runs 0° — 90° — 0° — 90° — 0°, just as if made with the amateur astronomer in mind.

One of the circles just described has been very carefully mounted on an accurately cut plywood backing (with a piece of white paper between so the black graduations will be very distinct) and the whole, together with lens and pointer, is fastened to the 10-inch reflector at our home observatory. Excepting when the telescope is pointed at an object near the horizon, readings are seldom in error by as much as $0^\circ.1$.

J. HUGH PRUETT
University of Oregon, Eugene, Ore.

ASTRONOMICAL ANECDOTES

THE "GLORIOUS EIGHTH," RITTENHOUSE, AND CRACKED BELLS

WHEN the first session of the meeting of the American Astronomical Society was adjourning for the usual photograph, on June 28th, there was an announcement to the effect that the platform to be seen in the court was not the same one erected in 1769 for the observation of the transit of Venus on June 3rd of that year. I have a clipping from the late Philadelphia *Public Ledger,* bearing the by-line Joseph Jackson, which tells the story of that earlier platform.

While the anniversary celebrations of the Nation's Birthday have been celebrated on July 4, excepting when that day fell upon Sunday, the first celebration of the event was held on July 8, 1776.

This was in accordance with the resolves of the Congress, which, after the Declaration had been adopted, voted to have it printed and distributed throughout the Colonies, so that it might be read to the people. The first public reading was in Philadelphia in the State House Yard (Independence Square), four days after its adoption.

There are three accounts of this historic event, written by persons who witnessed it; but only one of them was written at the time—that which appears to be in the diary of Christopher Marshall, who was a member of the Committee of Safety.

He gave a brief but accurate picture of the scene in these words: "July 8—Warm sunshine morning. At 11 went and met committee of inspection at Philosophical Hall; went from there in a body to lodge; joined the Committee of Safety; went in a body to State House Yard, where, in the presence of a great concourse of people, the Declaration of Independence was read by John Nixon. The company declared their approbation by three repeated huzzas. The King's arms were taken down in the court room, State House, same time . . . . Fine starlight, pleasant evening. There were bonfires, ringing bells, with other demonstrations of joy upon the unanimity and agreement of the Declaration."

John Nixon, who read the Declaration, was not an official but a volunteer. That office properly belonged to the Sheriff of the county, at that time William Dewees. For some reason, Dewees refused to read the paper and Nixon, afterward colonel in the Revolutionary Army, stepped forward and offered to take his place.

Nixon stood on the platform of the old astronomical observatory, which had been erected in the State House Yard in 1769, that Rittenhouse might observe the transit of Venus on June 3 that year. This wooden structure remained in place for many years.

Of the other two accounts of the first "Fourth" celebration, one was written by Mrs. Deborah Logan, 50 years after the event, and the other by Charles Biddle, in his *Autobiography,* only a few years earlier . . . . Biddle wrote, "There were very few respectable people present," and Mrs. Logan wrote, "The first audience was neither very numerous nor composed of the most respectable class of citizens."

There are a few items to add here. For one, Rittenhouse did supervise the establishment of the observing station, but he did not occupy it; he was at his own observatory in Norriton, while (I believe) Provost Smith of the University of Pennsylvania was in the State House yard, using a Gregorian telescope now in The Franklin Institute. There was another group at Cape Henlopen.

The Declaration was adopted on July 4th, and authenticated by the signatures of John Hancock, president of Congress, who signed in a large round hand "so that John Bull could read it without spectacles," and Charles Thomson, secretary. Following the reading at 12 noon on Monday, July 8th, it was engrossed, and signed by members of Congress on August 2nd. It may be an argument for the World calendar enthusiasts that July 8th in that worthy calendar falls on Sunday, so we could celebrate on the next day, Monday, the first public reading of the Declaration, quite fittingly.

A third point is that the "Philosophical Hall" mentioned in the account is the one in which the meeting of the American Astronomical Society was held in June. The American Philosophical Society, founded in 1743 largely through the efforts of Benjamin Franklin, is the oldest learned society in the United States.

The Liberty Bell, rung on July 4, 1776, to signalize the adoption of the Declaration, was cracked on another July 8th, in 1835, while tolling the death of John Marshall.

An astronomical story of another cracked bell comes to mind. George Bassett Clark, at the age of 17, was a student at Phillips Academy at Andover, Mass. The dinner bell broke one day, and young Clark, remembering that Newton had made telescope mirrors of bell metal, collected the fragments, melted them into a 5-inch disk, and started to work. His father, Alvan Clark, got interested, then his brother, Alvan G. Clark. They had made several small objectives by 1860, when they were called upon to make the 18½-inch telescope intended for the University of Mississippi; the instrument finally went to the Dearborn Observatory in Evanston, Ill.

R.K.M.

OBSERVER'S PAGE

BY JESSE A. FITZPATRICK

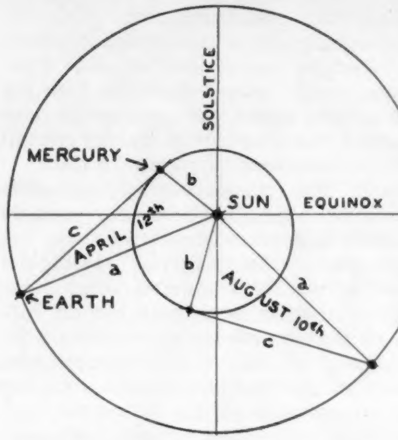
All times mentioned on the Observer's Page are Eastern war time.

FAVORABLE AND UNFAVORABLE ELONGATIONS OF MERCURY

VARIOUS factors influence the interval between sunset and Mercury's setting when the planet is at greatest eastern elongation, as it is on the 10th of this month. These same factors determine how much ahead of the sun it will rise at greatest western elongation. In a **favorable** elongation, the interval in either case is large, as much as 2½ hours for observers at 50° south latitude; in an unfavorable case the elongation itself may be near the maximum of 28°, but the interval nevertheless can be small, so that twilight seriously interferes with observation of the planet.

The first factor is the eccentricity of the planet's orbit, amounting to 20 per cent, so that Mercury's distance from the sun varies considerably. Elongations near perihelion may be as small as 18°; those near aphelion as large as 28°, with the one this month amounting to 27° 25′. In the case of the planet Venus, with its nearly circular orbit, our line of sight at greatest elongation is always nearly perpendicular to the planet's radius vector. For Mercury, however, the angle between earth and sun as seen from the planet may be considerably larger or smaller than 90°. On January 31st it was 76°, and on April 12th it was 101°. In order to compute this angle and the value of the elongation, the three linear distances: (a) earth to sun, (b) sun to Mercury, (c) Mercury to earth, must be obtained from the **Ephemeris:** The triangle thus formed is solved by ordinary trigonometric formulae. For August 10th, the respective distances, in astronomical units, are (a) 1.0134574, (b) 0.466651, (c) 0.895578. The angle at Mercury comes out very nearly 90°.

The second factor is the 7° inclination of Mercury's orbit to the plane of the ecliptic, greatest for any planet except Pluto. Thus Mercury may appear considerably north or south of the sun; on April 12th its declination was 9° greater than the sun's, whereas on August 10th it will be at +4° 20′ while the sun is at +15° 41′. Part of this difference, however, is caused by the inclination of the ecliptic to the equator, which may be considered the third factor.



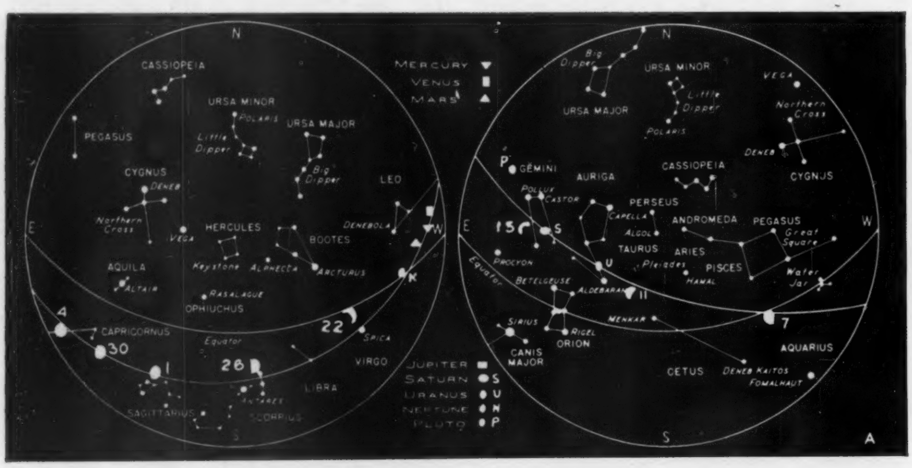
This obliquity of the ecliptic tends to give Mercury a more northerly declination than the sun at eastern elongations in the months of March and April and at western elongations in September and October; more southerly declinations are produced at western elongations in March and April and at eastern ones in September and October. This produces certain definitely favorable seasons for the observation of Mercury elongations, but these, in turn, are affected by the fourth factor which is the observer's latitude.

Those living in the torrid zone find almost any time of the year favorable, with the variation of Mercury's distance from the sun the most important factor in producing favorable elongations. But observers in the north temperate zones can best see Mercury at elongations after sunset in the spring and before sunrise in the autumn (the first of the cases described in the preceding paragraph). Observers in the south temperate zone find just the opposite to be true—when Mercury is south of the sun they are favored, so this August 10th elongation is particularly important for them. In The SKY for April, 1940, page 18, a specific case of a very favorable elongation for the Southern Hemisphere is discussed, and figures are given to show how our southern friends may see the "elusive" planet for 45 minutes **in a completely dark sky.**

Amateurs familiar with the daily paths of the sun and stars across the sky will have no trouble realizing why, in the Northern Hemisphere, it is advantageous to have Mercury north of the sun. In mid-northern latitudes, when the sun increases its declination by 23½ degrees from March 21st to June 22nd, it lengthens the daytime from 12 to 15 hours on the average. In other words, the time from sunrise to noon increases from six hours to 7½, and an equal time is added from noon to sunset. Any planet or star at the same declination as the sun will take the same time to go from the meridian to the western horizon, that is, it will have the same semidiurnal arc.

Thus, on **August 10th**, the sun's average right ascension is 9^h 20^m, and its

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 6:30 a.m. on the 7th of the month, and at 5:30 a.m. on the 23rd. At the left is the sky for 8:30 p.m. on the 7th and for 7:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury will be at greatest elongation east, 27° 25′, on August 10th. See the accompanying article.

Venus, in Leo and just entering Virgo at the end of the month, will set an average of 40 minutes after the sun. It will be about 1° north of Regulus on the 9th, and on the 13th will be in conjunction with and 34′ north of Jupiter. On the 31st it will be 36′ north of Beta Virginis.

Mars, in Leo and Virgo, will be a faint and uninteresting object, too close to the sun to be well observed.

Jupiter is in conjunction with the sun on the 31st, passing from the evening to the morning sky.

Saturn is well up in the morning sky at sunrise, situated in Gemini.

Uranus is in Taurus; **Neptune** is in Virgo; and **Pluto** is in Cancer.

declination +15° 41′. Denebola, the bright star in the tail of Leo, the Lion, is at 11^h 46^m, +14° 52′. Therefore, Denebola will cross the meridian during the afternoon 2^h 26^m after the sun does, and touch nearly the same place on the horizon just about 2^h 26^m after the sun.

Mercury, meanwhile, is at right ascension 11^h 02^m (average) and declination +4° 20′ (average). On page xiv of Norton's **Star Atlas** (8th edition), the table of semidiurnal arcs shows that for an observer at 40° north latitude a star at declination +5° (like Mercury in this case) requires 6^h 17^m to go from meridian to horizon, while one at +15° (case of sun and Denebola) requires 6^h 52^m. It is evident, then, that although Mercury will cross the meridian on August 10th about 1^h 42^m after the sun, it will set slightly more than one hour after sunset.

Twilight will last about 1^h 45^m on this date. Nearness to the celestial equator places Mercury's setting not far north of the west point of the horizon, so when the sky is dark enough to see it, the planet ought to be practically due west. Most of the 27° 25′ between it and the sun is used up in a direction parallel to the horizon! For a favorable elongation, this distance should extend vertically, as it did in April. Most amateurs know that a similar situation produces the effect called the harvest moon (see The SKY, September, 1941).

Those familiar with the **Nautical Almanac** and the **American Ephemeris** are urged to try other specific examples of Mercury elongations for themselves. The Graphic Time Table of the Heavens, published in **Sky and Telescope** each January by courtesy of the Maryland Academy of Sciences, shows the dates of Mercury elongations throughout the year, and also includes the duration of twilight, so that one may see just when Mercury lags most behind the sun in the evening or precedes it most in the morning.

Many readers have inquired why this sunset-Mercury or Mercury-sunrise interval is not always greatest at elongation, the case this month being the most noticeable in 1944. Reference to the Graphic Time Table shows that beginning as early as July 20th, Mercury may be seen setting more than an hour after the sun at latitude 40° north. Immediately after August 10th, the interval rapidly becomes less, so that searching for Mercury should precede, not follow, the date of greatest elongation.

The explanation is found in Mercury's changing declination, compared with that of the sun, and is best shown by the figures in the accompanying table. It shows that on July 20th, Mercury set about 68 minutes after the sun; on August 10th only 63 minutes later; and on August 20th, 43 minutes. The figures in the table are roughly for latitude 40° north; observers in other latitudes must obtain their own semidiurnal arcs in order to figure values for the last four columns in the table.

Date	*Sun* *R.A.* h m	*Sun* *Dec.* ° ′	*Mercury* *R.A.* h m	*Mercury* *Dec.* ° ′	*R.A. diff.* min.	*Sun path*	*Merc. path*	*Path diff.* min.	*Setting interval** min.
July 10	7 18	+22 13	8 04	+22 17	46	7:20	7:20	0	46
July 20	7 58	20 36	9 18	17 08	80	7:12	7:00	12	68
July 30	8 38	18 29	10 16	10 55	98	7:03	6:37	26	72
Aug. 10	9 20	15 41	11 02	4 20	102	6:54	6:15	39	63
Aug. 20	9 58	12 24	11 24	0 03	86	6:43	6:00	43	43
Aug. 30	10 34	9 02	11 18	—0 35	44	6:32	6:00	32	12

*Setting interval is the R.A. difference minus the semidiurnal path difference, that is, the 6th minus the 9th column.

OCCULTATIONS FOR TEXAS

Predictions are for longitude 98° 0′.0 W., and latitude 30° 0′.0 N. The data include: date, name of star, magnitude; G.C.T. in hours and minutes, **a** and **b** quantities in minutes, and position angle in degrees, at immersion; G.C.T., **a** and **b** quantities, and P.A., at emersion.

Aug. 6, 74 Aqr, 5.9; 8:51.1, —2.5, —0.1, 88°; 10:00.1, —1.0, +1.4, 213°.

Aug. 10, Xi² Cet, 4.3; . . .; 6:03.7, —0.1, +1.1, 263°.

Aug. 12, 63 Tau, 5.7; 8:54.0, —0.8, +0.7, 99°; 9:50.6, —0.3, +2.5, 216°.

Aug. 13, 353 B Tau, 6.4; 11:01.6, +0.5, +4.5, 12°; 11:41.2, —3.1, —1.7, 310°.

Aug. 15, 120 B Gem, 6.5; 11:06.0, +0.6, +3.6, 79°; 11:43.9, —1.8, —1.4, 318°.

Aug. 29, 14 Sgr, 5.7; 5:35.5, —0.5, +1.1, 37°; 6:22.5, —1.6, —2.7, 314°.

The predictions, computed voluntarily by Miss Tecla Combariati and J. Lynn Smith, of the U. S. Naval Observatory, are similar in form to those given in the **American Ephemeris** for 1944, pages 365-372.

Immersions at the dark limb (while the moon is waxing) are most desired. Reports should include the exact time of the phenomenon, and the observer's precise latitude, longitude, and elevation.

OCCULTATIONS---AUGUST, 1944

Local station, lat. 40° 48′.6 north, long. 4^h 55^m.8 west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
Aug. 6	5.9	74 Aquarii	5:31.8 a.m.	95°	6:26.1 a.m.	212°
10	4.3	Xi² Ceti	1:31.1 a.m.	42°	2:30.9 a.m.	267°
12	5.7	63 Tauri	5:34.9 a.m.	105°	6:37.4 a.m.	212°
27	7.4	BD —20° 4661	10:31.9 p.m.	79°		
29	6.8	BD —22° 4977	9:50.3 p.m.	132°		
30	6.9	BD —22° 5021	1:33.0 a.m.	78°		

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

PERSEID METEOR SHOWER

For Northern Hemisphere observers, August represents the peak month for meteors, chiefly because the Perseid swarm reaches its maximum about August 12th and the Perseids are numerous for a week before and after that date. They include many bright, long-traveling meteors, and a considerable number are reported early in the evening. It is not necessary to watch their radiant point, in the constellation of Perseus, and meteors seen farther from the radiant usually have the longest trails. Near the Perseid maximum, and after midnight in clear skies, the number of all meteors observed may reach 50 per hour or more. The waning moon will interfere somewhat with attempts to count faint Perseids.

PHASES OF THE MOON

Full moon	August 4,	8:39 a.m.
Last quarter ...	August 10,	10:52 p.m.
New moon	August 18,	4:25 p.m.
First quarter ...	August 26,	7:39 p.m.

JUPITER BY DAY

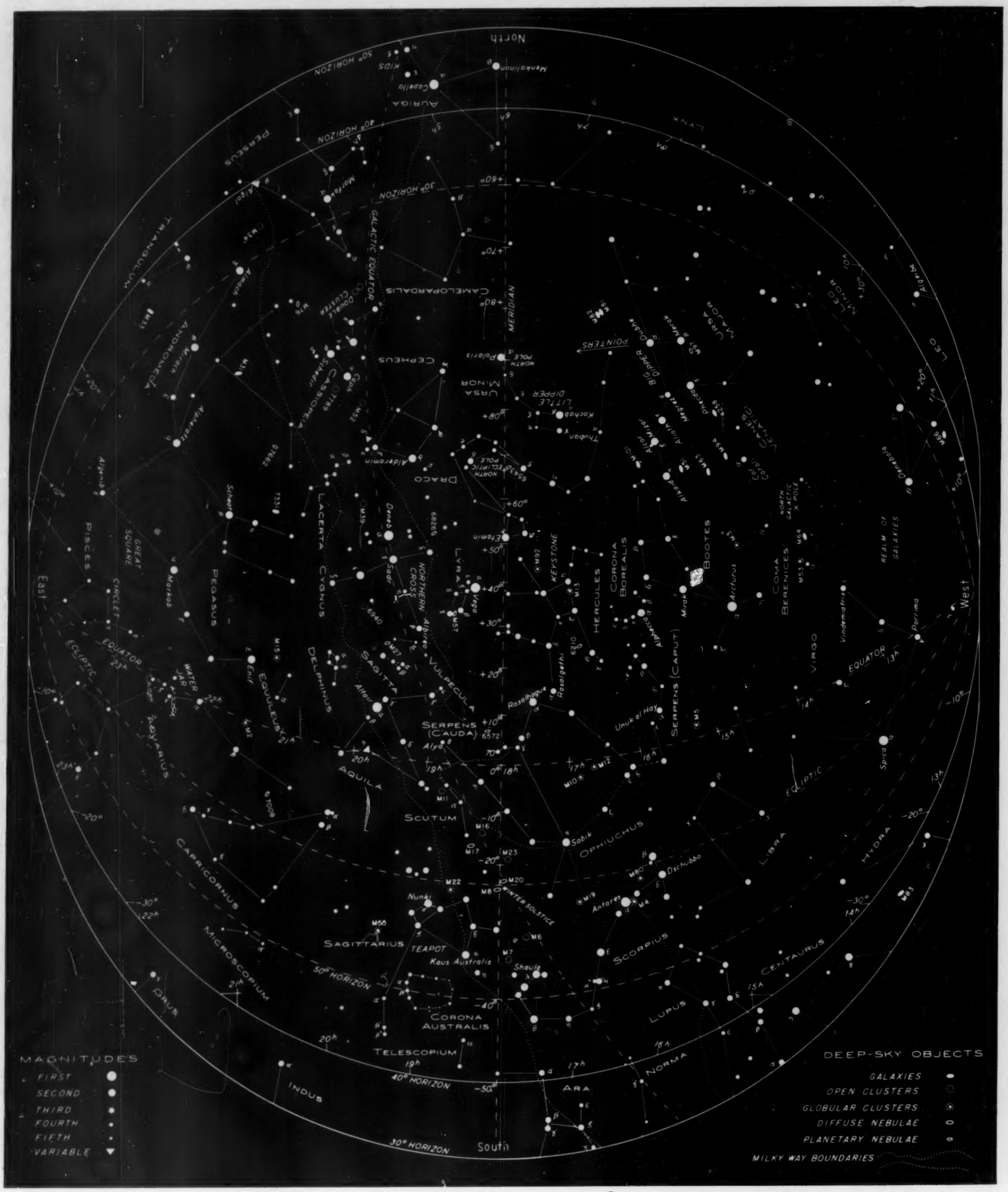
Robert Harper, of Cincinnati, writes that while it was cloudy at the time of the occultation of Jupiter on April 30th, afterwards it cleared up, and Jupiter was seen about 15′ from the edge of the moon. He had no trouble picking up the planet with the naked eye, and keeping it in sight for the rest of the afternoon.

EXPLORING THE HEAVENS

(Continued from page 11)

realization of their true complexity and primeval grandeur, for in them every day the most terrific explosions in the solar system are going on—they are vast hurricanes in whose depths many earths would be lost. Every time a filament shrinks or a nucleus breaks up the equivalent of continents is being disrupted by upheavals paling our Krakatoas into nothing. Langley wrote of seeing a region in a spot, bigger than the United States, disappear in 20 minutes, and modern motion-picture technique, applied to the sun at such solar observatories as McMath-Hulbert at Lake Angelus, Mich., reveal equally rapid changes in the vast prominences which live over sunspots.

One sunspot, October 11, 1938, part of a larger group, was long enough to hold nine earths placed in a row, yet most of it shrank away in a few days. In the drawings of Langley the detailed beauties of sunspots are fully shown. Those who wish to observe sunspots continually can obtain their own data with which to try to interpret the nature of sunspots and their relation to other solar events and some terrestrial phenomena; none of these problems is satisfactorily solved as yet.



DEEP-SKY WONDERS

AMONG marvels for observation in the August skies are the objects listed here. The informal descriptions portray appearances in common telescopes. Numbers in parentheses are from Norton's **Star Atlas.**

Ophiuchus. NGC 6572, 18h 09m, + 6° 50′; planetary; wee blue oval in good-sized amateur telescope.

Cygnus. NGC 6826 (73⁴), 19h 43m, +50° 23′; planetary; small gray-blue globe. M39, 21h 28m.6, +48° 00′; cluster of 25 bright stars.

Vulpecula. NGC 6940 (8⁷), 20h 30m.4, +27° 58′; cluster of 100 stars.

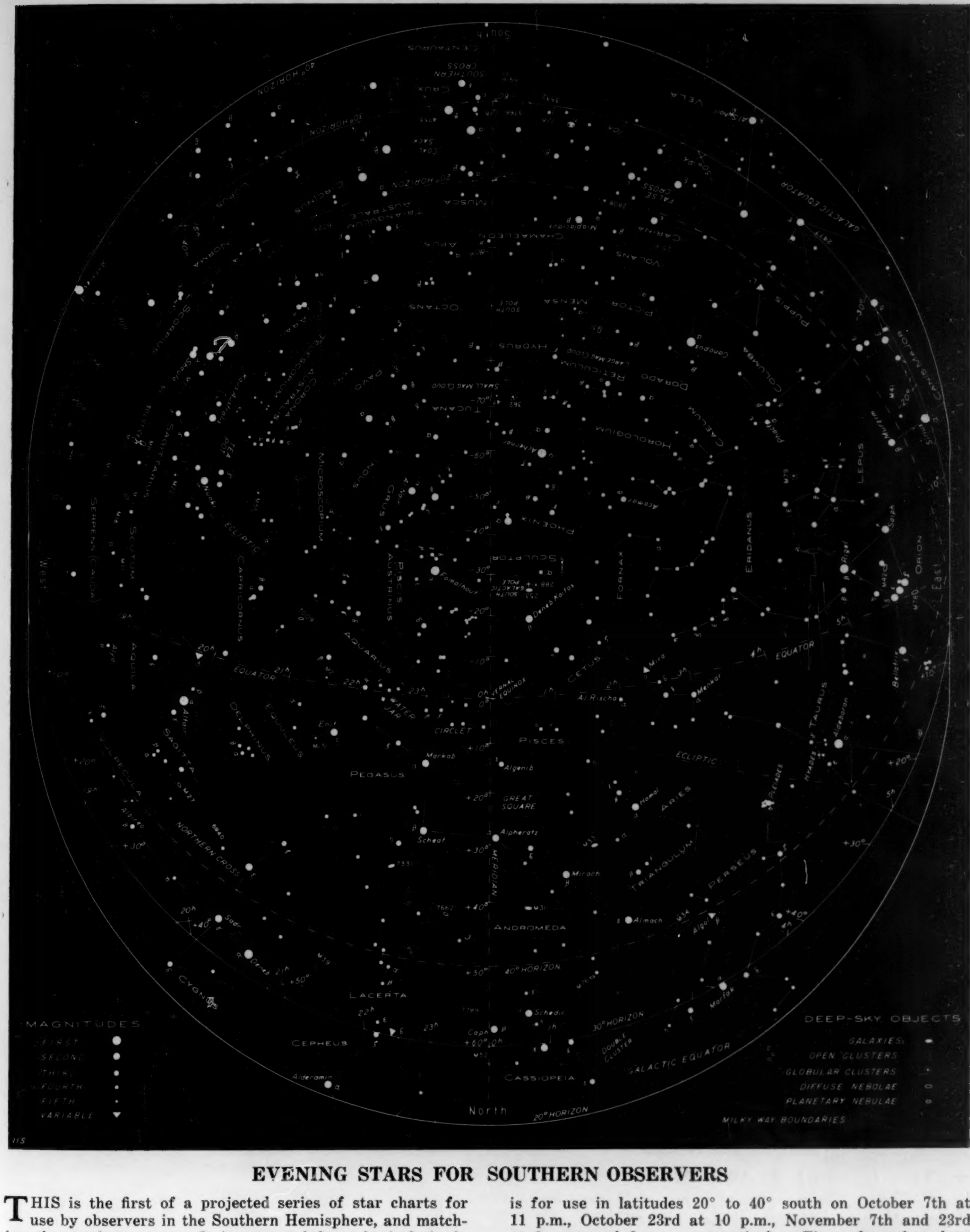
Pegasus. M15, 21h 27m.4, +11° 56′; choice globular. NGC 7331 (53′), 22h 34m.8, +34° 10′; oval galaxy.

Aquarius. M2, 21h 30m.6, —1° 04′; large globular.

L. S. COPELAND

STARS FOR AUGUST

from latitudes 30° to 50° north, at 10 p.m. and 9 p.m., war time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.



EVENING STARS FOR SOUTHERN OBSERVERS

THIS is the first of a projected series of star charts for use by observers in the Southern Hemisphere, and matching the northern maps. It is prepared for a basic latitude of 30° south, but may be used conveniently 20 degrees on either side of that parallel. These southern charts will appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. When 12 charts have been produced, and if interest warrants, a special edition of **Sky and Telescope** may be published each month carrying observing material for Southern Hemisphere observers. This chart is for use in latitudes 20° to 40° south on October 7th at 11 p.m., October 23rd at 10 p.m., November 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly: four minutes earlier per day. These are local mean times which must be corrected for standard time and war time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts.

BEGINNER'S PAGE

By Percy W. Witherell

Man and His Expanding Universe — IX

THE improvement of telescopic equipment and more skillful observing increased the number of known bodies in the solar system. In 1789, Sir William Herschel discovered Mimas and Enceladus revolving around Saturn, and George P. Bond discovered Hyperion in 1848. William Lassell added Ariel and Umbriel to the family of Uranus in 1851. By this date, Saturn was known to have eight satellites, and Uranus, four, as Herschel had discovered Titania and Oberon in 1787. In the case of Jupiter, only the four Galileo had found in 1609 were yet known.

The use of mathematics to predict the future movements of comets and other known bodies has already been mentioned in this series. Ability to show the existence of an unknown body by the unexplained perturbations it caused in the orbit of a known body is strikingly illustrated in the discovery of Neptune. Observations of Uranus from the time of its discovery in 1781 until 1845 showed that the observed and computed orbits differed by nearly two minutes of arc, after allowing for the influences of Jupiter and Saturn.

Leverrier, after a skillful computation, asked Galle in the Berlin Observatory to direct his telescope to a point on the ecliptic in longitude 326°, where he should find a new planet of the 9th magnitude. On September 23, 1846, half an hour after the search was begun, Neptune was found within 52″ of the predicted location. J. C. Adams had made a similar prediction some weeks earlier, and J. Challis at Cambridge had actually made two observations of Neptune, but had not entered its positions on his chart and so did not realize his discovery. Investigation of previous maps of the region later showed that Neptune had been plotted as a star on several occasions, but its disk is so small and its motion so slow that its planetary nature had not been recognized.

Photography revolutionized telescopic observations, especially after the production of the dry plate. John W. Draper obtained the first photograph of the moon in 1840 with an exposure of 20 minutes. From 1849 to 1851, photographs of the moon were made with the 15-inch refractor at the Harvard Observatory. As this telescope is designed for visual observation, its definition on a photographic plate is not as perfect as that of modern instruments figured for photographic use. In 1850, the first photograph of a star was obtained on a daguerreotype plate with the 15-inch telescope. Alpha Lyrae, magnitude 0.14, and Alpha Geminorum, 1.58 (its two components producing an elongated image), were successfully photographed. Attempts to register any star fainter than the 2nd magnitude were unsuccessful. With the introduction of the collodion wet plate and a more accurate driving clock, images were obtained of Mizar and Alcor with an exposure of 80 seconds. By 1857, images of 6th-magnitude stars were obtained.

Bond, in 1859, showed that intensity and size of the photographic images increased with the magnitude and could be used to determine the relative brightnesses of the stars. In 1857 he wrote to William Mitchell, of Nantucket (father of the famous Maria Mitchell), and imagined the wonderful possibilities of future discoveries if instruments could be constructed with enough light-gathering power to reach to the 10th magnitude.

Lenses designed for photographic exposures and more and more sensitive plates soon resulted in the discovery of numerous other members of the solar family which had previously escaped notice because they were too faint to be observed visually. Today, Jupiter is known to have 11 satellites, Saturn, nine, Uranus, four, and Neptune, one. Mars has two; Venus and Mercury apparently have none, and Pluto, the latest major planet to be acknowledged as a member of the solar family, is so far away that little is known about it.

Besides these more important members of the family, hundreds of asteroids were being discovered so rapidly that a special bureau was established to keep track of them. When the numerous comets and meteor streams that are attached to old Sol are also considered, his family becomes a large one, occupying a considerable volume, and all traveling at 12.5 miles per second through space in the general direction of Vega.

The known "local universe" of man is thus about eight billion miles across, but when we remember that the nearest star is over 25 million million miles away, "our universe" is not as important as mankind originally thought.

Next we shall consider the relation of the sun and family to its neighbors.

★ ★

PLANETARIUM NOTES

Sky and Telescope is official bulletin of the Hayden Planetarium in New York City and of the Buhl Planetarium in Pittsburgh, Pa.

★ **THE BUHL PLANETARIUM** presents in *August,* BY ROCKET TO THE MOON. (See page 3.)

No one has ever predicted that the airplane could take us on a trip to Mars. The lack of air between the planets precludes that, but for a ship propelled by rocket motors no air is needed. In this sky show we see just what the principle of the rocket is, and how we have produced rocket guns and rocket planes in the present war. Then we board an imaginary passenger rocket ship of the future, which whisks us swiftly to the moon—to the floor of a lunar crater. We explore the moon's mountainous surface, its craters and "seas," its weird and colorful scenery. Our own earth, seen hanging in the sky, eclipses the sun. At length we turn our rocket ship about, and head for home.

★ **THE HAYDEN PLANETARIUM** presents in *August* and *September,* A TRIP TO THE MOON. (See page 3.)

The most exciting journey you'll ever take—by rocket ship zooming up through the earth's atmosphere and landing in a crater on the moon. Here you will see exactly what you would if you *could* travel to the moon—stars shining in a black noon sky, an entire absence of weather, the sun eclipsed by the earth. Come along—it's fun!

★ SCHEDULE BUHL PLANETARIUM

Mondays through Saturdays (except Tuesdays) ..... 3 and 8:30 p.m.
Sundays and Holidays ..... 3, 4, and 8:30 p.m.
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★ STAFF—*Director,* Arthur L. Draper; *Lecturer,* Nicholas E. Wagman; *Manager,* Frank S. McGary; *Public Relations,* John F. Landis; *Chief Instructor of Navigation,* Fitz-Hugh Marshall, Jr.; *Instructor, School of Navigation,* Edwin Ebbighausen.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays ..... 2, 3:30, and 8:30 p.m.
Saturdays ..... 11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays ..... 2, 3, 4, 5, and 8:30 p.m.

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Sir Isaac Newton

Inquiring into a PHENOMENON *he created a* SCIENCE

THE flashing colors of a diamond and the clear tints of a rainbow had been seen by countless people before Sir Isaac Newton asked, "How are these colors formed?"

His memoir on "Opticks" records the answer in a quaintly worded Theorem: "The light of the sun consists of rays differently refrangible." This conclusion, based on many experiments with crude glass prisms and a pencil of sunlight slanting into a shuttered room, laid the foundation of all spectroscopy. Further, it led Newton to invent the reflecting telescope, because he thought that his prismatic colors would make an achromatic lens forever impossible.

Today, Sir Isaac Newton's successors are exploring new worlds of astronomy, chemistry, metallurgy, photography and vision with lenses and prisms in instruments of constantly increasing accuracy. Many of these modern explorers—in industry, education and the armed forces—have called on Perkin-Elmer for help in blazing new trails in optical science.

This exchange of ideas with leaders in the sciences plus war-inspired production methods will enable Perkin-Elmer to incorporate in post-war scientific optical instruments extra refinements that will open up new avenues of investigation.

WHAT PERKIN-ELMER MAKES

Custom-built optical instruments for industrial analysis, control, and inspection.

New optical devices to solve specific problems, such as the all-purpose infra-red spectrometer.

Special elements such as fine lenses, prisms, flats, photographic objectives, interferometer plates, retardation plates, Cornu prisms, Rochon prisms, Nicol prisms.

Perkin-Elmer is now 100% in war work, but after the war will resume manufacture of such peace-time products as Schmidt cameras, refracting and reflecting telescopes, equatorial mountings, oculars, direct-vision prisms, polarizing eye pieces, and other equipment.

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